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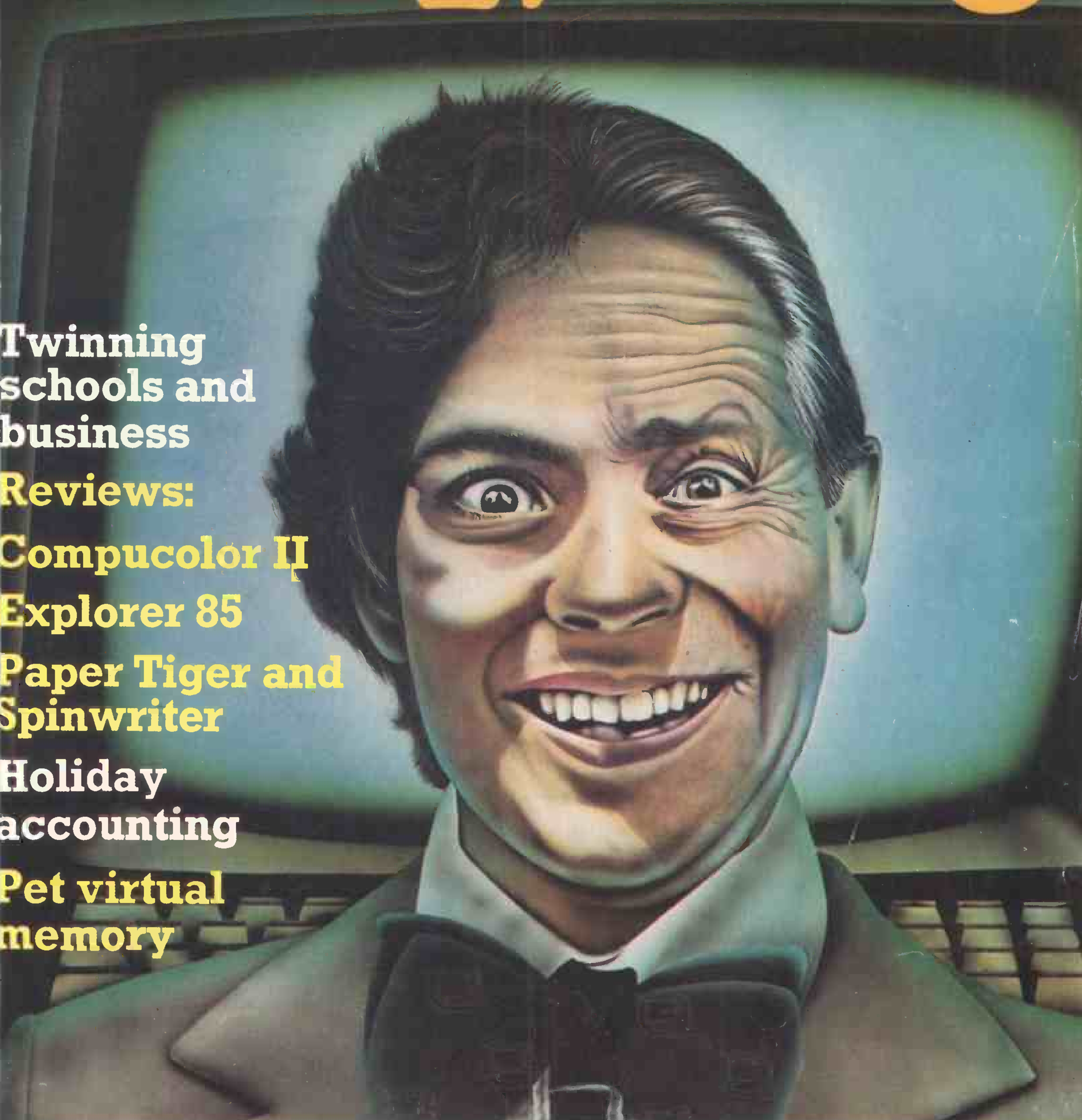
Practical Computing

July 1981 Volume 4 Issue 7



Twinning schools and business

Reviews:

Compucolor II

Explorer 85

Paper Tiger and Spinwriter

Holiday accounting

Pet virtual memory

MicroCentre introduce . . . . . . System Zero

New System Zero Computer with quad-capacity DDF disk drive. The system includes built-in diagnostics for a quick system test of memory, controller and disk drives

Basic System Zero £587
System Zero/D with DDF £2355

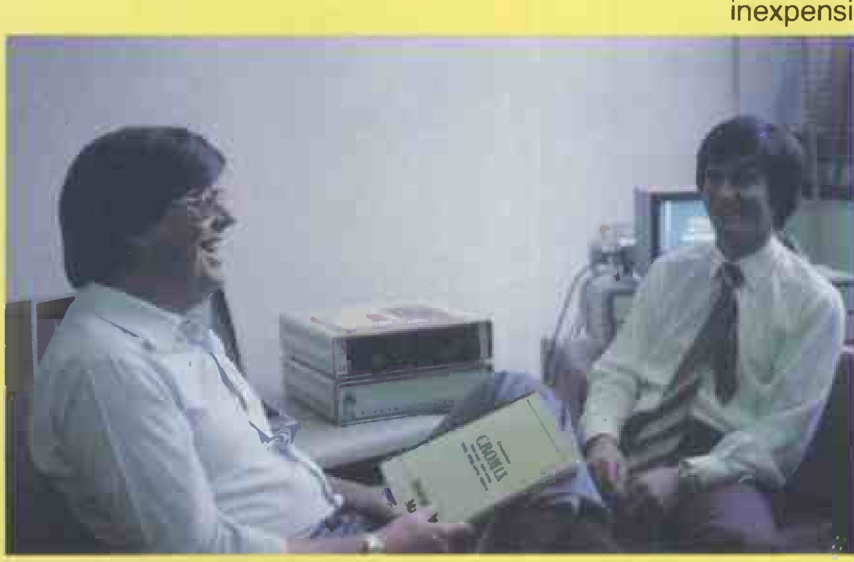
The System Zero is a small computer especially designed for dedicated applications. It is particularly useful in process control situations.
In the basic model you get Cromemco's famous Z-80A single card computer, 1k of RAM, 4k of ROM, Control Basic, and an attractive cabinet. The motherboard provides 3 extra card slots on the S-100 bus, for tailoring the system to particular applications. The basic model is designed for ROM-based programs, but it can be expanded by the addition of memory and I/O cards. It is fully compatible with all Cromemco peripherals, including floppy disks and hard disk systems. Suitably configured the System Zero can run any Cromemco operating system or software package.

System Zero/D

This special version of the System Zero has 64k of fast RAM, and a model DDF dual disk drive. It includes two double-sided double-density 5 inch disk drives giving a total of 780k bytes storage; and RDOS-2, a new resident disk operating system with terminal and printer drivers, and self-test diagnostics.
The System Zero/D is an exceedingly inexpensive development computer ideal for setting up dedicated applications to run in the basic model. It will support Cobol, Fortran IV, Ratfor, Structured Basic, Lisp, RPG II, Word Processing, DBMS, and the full range of Cromemco's business applications software.

Operating system

The System Zero/D will run any Cromemco operating system provided sufficient memory is available. The mimimun configuration of 4k ROM runs control Basic; with 64k RAM the system will run RDOS-2 or CDOS (compatible with CP/M); and with 128k the Zero/D will run the Cromix system (based on Unix).



At the recent UK launch of the System Zero Computer, Cromemco's Technical Director Roger Melen presented a System Zero/D with 128k memory running Cromix. Here he is seen discussing the system with MicroCentre Director Andrew Smith (right).

For Cromemco... call the experts

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2

CONTENTS

Prestel page number 357

Twinning schools and business—page 57.

Editor
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Assistant Editor
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Midlands office:
David Harvett 021-356 4838
Northern office:
Geoff Aikin 061-872 8861
Advertisement Secretary
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Chris Hipwell

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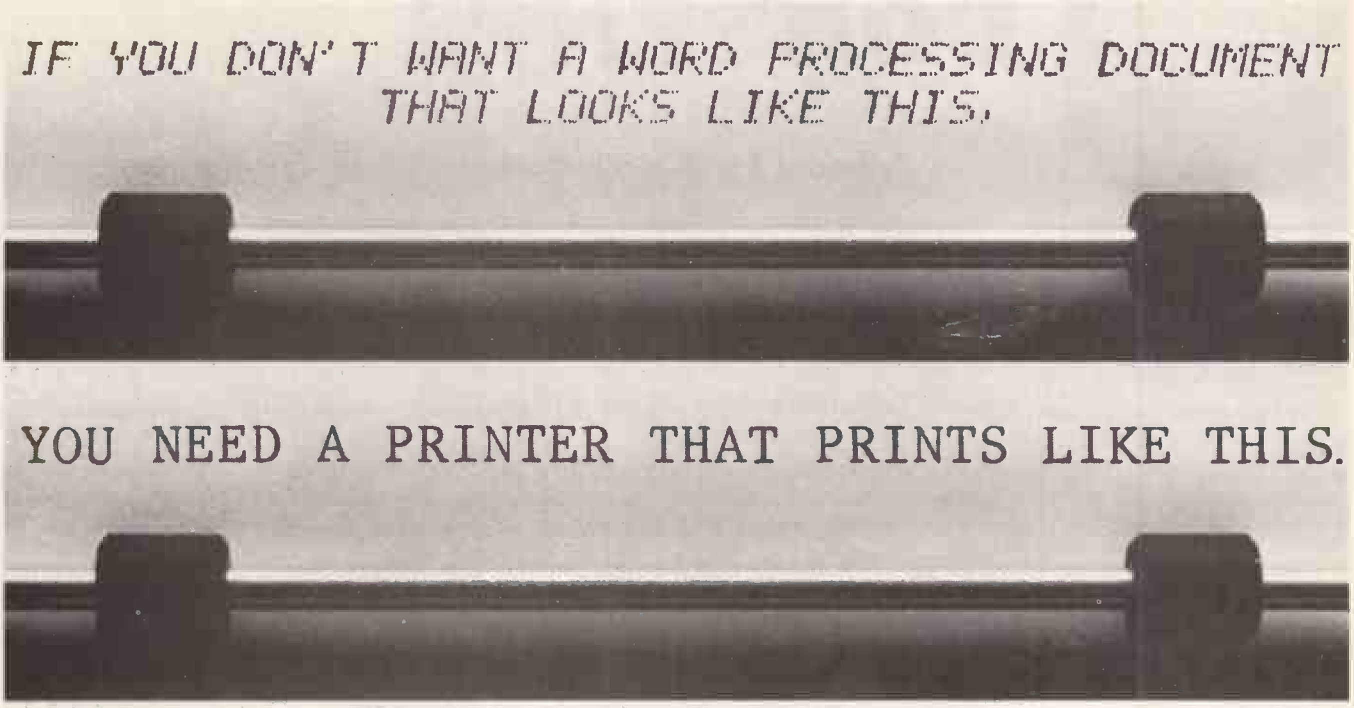

The more your system can do, the better your terminal should be. That's why, if you're adding text editing capability to your data processing system, you should also think about adding a quality daisywheel terminal to replace the matrix terminal you're using now. And the best-quality terminal you can buy is one by Qume.

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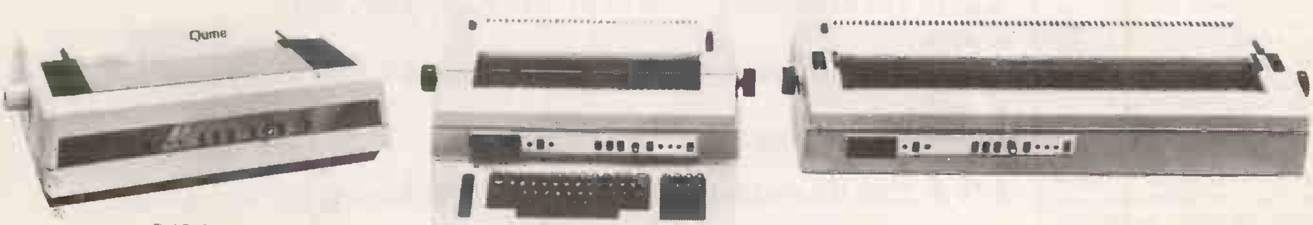

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- ☐ L M **WORD-STAR/MAIL-MERGE** — As above with option for production mailing of personalised documents with mail list from Datastar or NAD .... £315/£15
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☐ **TINY C** — interactive interpretive system for teaching structured programming techniques. Manual includes full source listings .... £45/£30

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System Specifications

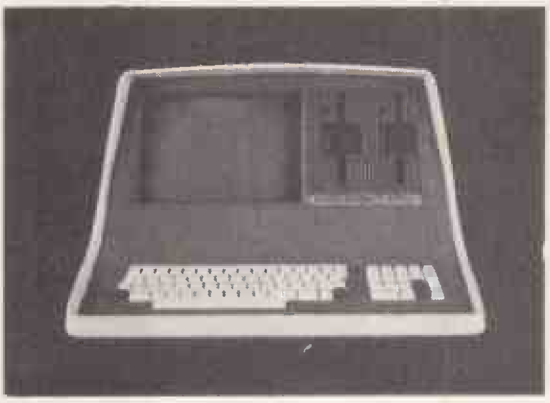
Twin Z80A's with 4MHZ Clock Frequency One Z80A (the host processor) performs all processor and screen related functions. The second Z80A is "down-loaded" by the host to execute disk I/O. When not processing disk data, the second Z80 may be programmed by the host for other processor relation functions.
8 bits
10 microseconds register to register
158
All interrupts are vectored

350K (700K on QD model) total bytes formatted on two double density drives. Optional 20.96 megabyte hard disk storage is available directly from Intertec.
250K bits/second
250 milliseconds. 35 milliseconds track-to-track.
4¼ inch mini-disk
300 RPM

32K bytes dynamic RAM. Expandable to 64K (socketed). 64K standard on QD model.
256 bytes of static RAM is provided in addition to the main processor RAM. This memory is used for program and/or data storage for the auxiliary processor.
1K bytes standard. Allows ROM "bootstrapping" of system at power-on. ROM storage is 2708 compatible and may be reprogrammed by the user for custom applications.

12-inch, specially focused. P4 phosphor, non-glare screen.
25 lines × 80 characters per line.
8 × 8 character matrix on a 8 × 10 character field.
Light characters on a dark background. Blinking or non-blinking.
20 MHZ.
Reversed image (block cursor).

Memory-mapped at 38 kilobaud. Serial transmission of data at rates up to 9600 bps.
Simplified RS-232 asynchronous. Parallel interface available.
Universal RS-232 asynchronous. Synchronous interface optional.
Printed circuit edge connector provided for connection of optional S-100 bus adaptor. Adaptor features internally mounted cardguide for up to one S-100 type accessory.
Enables display of all incoming and outgoing control codes.
Choice of even, odd, marking, or spacing.
Half or Full Duplex. One or two stop bits.
Direct positioning by either discrete or absolute addressing.



SuperBrain users get exceptional performance for just a fraction of what they'd expect to pay. Standard SuperBrain features include: two double density mini-floppies with 350K bytes of disk storage, 32K of ram memory (expandable to 64K) to handle even the most sophisticated programs, a CP/M Disk Operating System with a high powered text editor, assembler, debugger and a disk formator. And, with SuperBrain's S-100 bus adaptor, you can add all the programming power you will ever need ... almost any type of S-100 compatible bus accessory.
SuperBrain's CP/M operating system boasts an overwhelming amount of available software in BASIC, FORTRAN, COBOL, and APL. Whatever your application ... General Ledger, Accounts Receivable, Payroll, Inventory or Word Processing, SuperBrain is tops in its class. And the SuperBrain QD boasts the same powerful performance but also features a double-sided drive system to render more than 700K bytes of disk storage and a full 64K of RAM. All standard!

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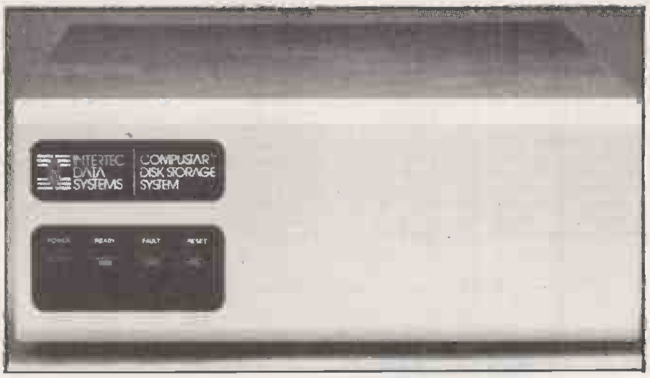

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The COMPUSTAR™ Family . . . .

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- Integral CRT, CPU, & Keyboard
- Download programmable

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- Can be used as a remote printer or a terminal interface device

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- Integral CPU, Disks, CRT & Keyboard

Model 30 VPU
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- 750K Dual Disk Capacity
- Integral CPU, Disks, CRT & Keyboard

Model 40 VPU
- 64K Internal Memory
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- Integral CPU, Disks, CRT & Keyboard

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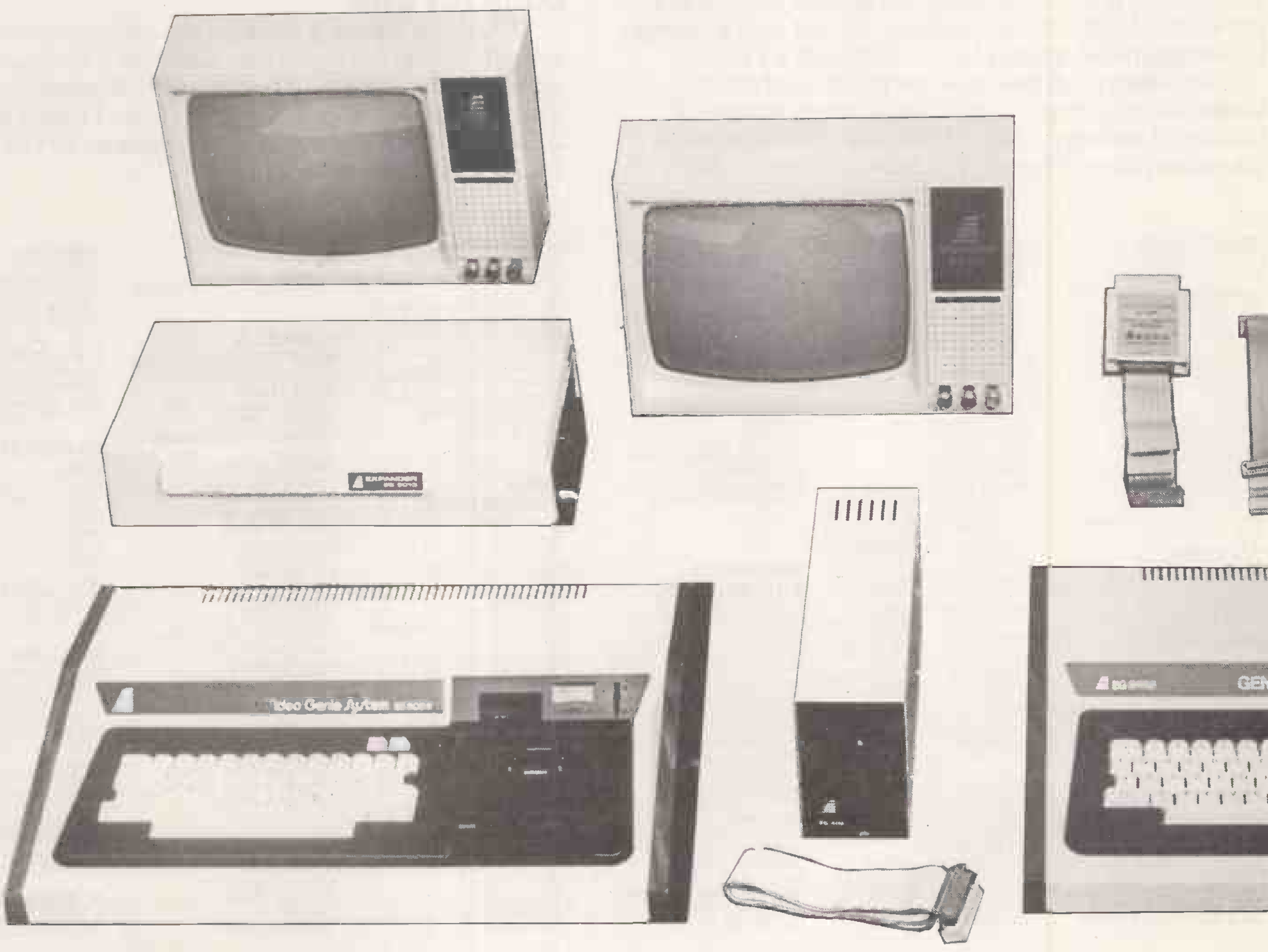

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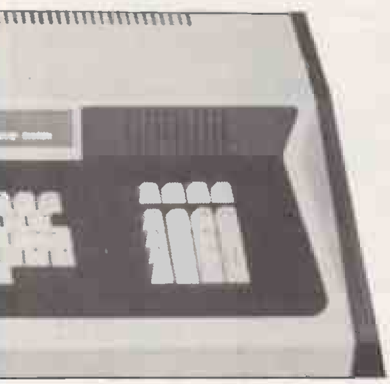

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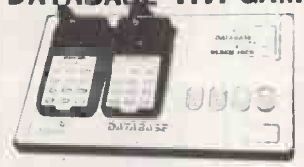

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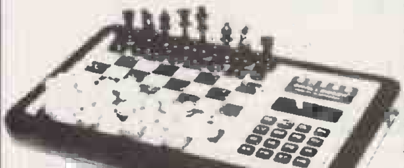

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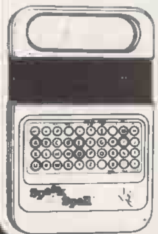

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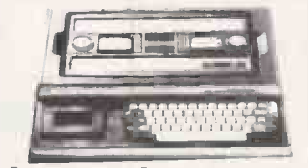

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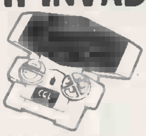

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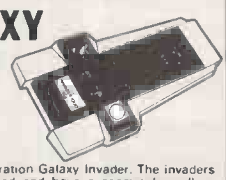

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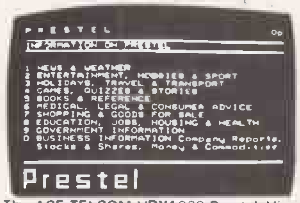

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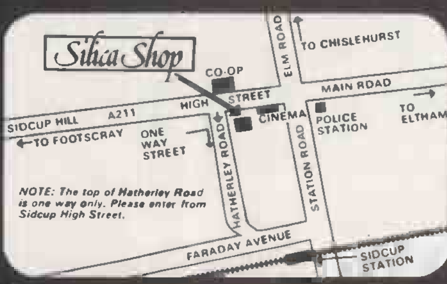

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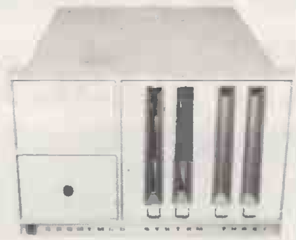

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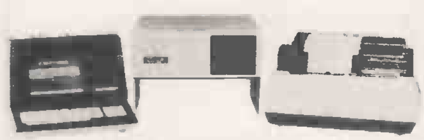

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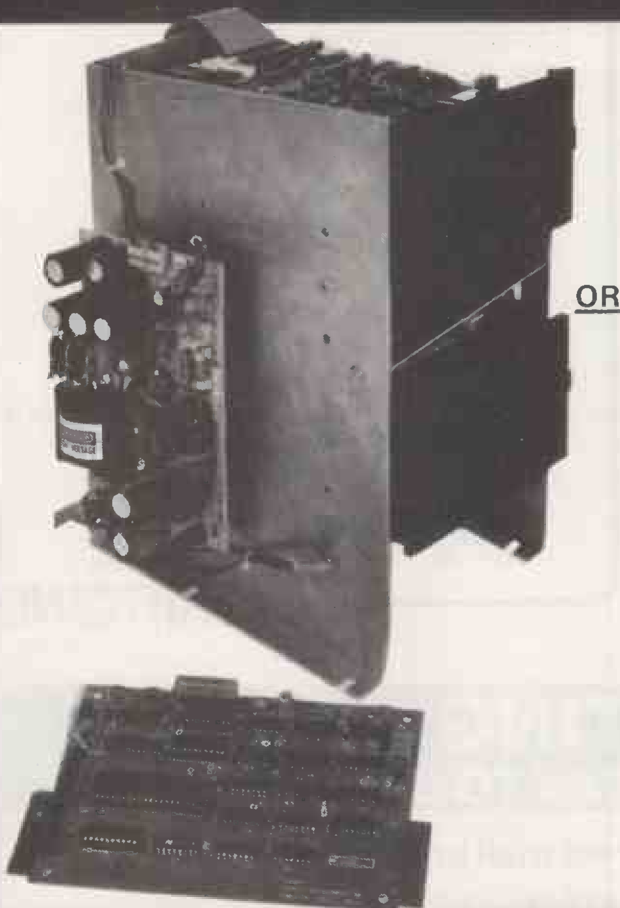

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2 x 40 TRACK DUAL DENSITY DRIVES

OR 2 x 80 TRACK DUAL DENSITY DRIVES

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240 VOLTS AC SWITCHED MODE POWER SUPPLY

ALL CONNECTORS AND CABLES

PRICES

KIT WITH 2 x 40 TRACK DRIVES	£599
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COMPSHOP LTD., 311, Edgware Road, London W2. Tel: 01-262-0387

LONDON COMPUTER CENTRE, 43, Grafton Way, London W1. Tel: 01-388-5721

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CROYDON COMPUTER CENTRE, 29a, Brigstock Road, Thornton Heath, Surrey Tel: 01-689-1280

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EMPRISE LTD., 58, East Street, Colchester Tel: 0206-865926

CAMBRIDGE COMPUTER STORE, 1, Emmanuel Street, Cambridge. Tel: 0223-65334

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MICRO CHIP SHOP, 190, Lord Street, Fleetwood, Lancs. Tel: 03917-79511

MICRO CHIP SHOP, 197, Waterloo Road, Blackpool. Tel: 0253-403122

MICRO CHIP SHOP, 93, Friargate, Preston, Lancs. Tel: 0772-22669

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The cartridge unit is based on the well-established Kennedy 6450 system.

The complete system costs £1,850 plus VAT and delivery is free in the UK mainland.

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COMPUCOLOR II

REVIEWED IN THIS ISSUE

THE SYSTEM

*16K User RAM
*Disk Drive
*Colour VDU 64x32 CHRS
*Excellent Colour Graphics Routines using 16384 Dot Resoloution
*Upper & Lower Case + Graphics in Two Sizes
*£50 Value Free Software

THE SOFTWARE

*Word Processor	£145
*Trend Spotter	£245
*VAT Package	£50
* + Lots of system software and games from	12.50
*Complete word processor system only	£1695
See write up	

Compucolor and Intecolor systems are ideally suited to process control and data capture & display applications

INTECOLOR 3600 Series

3600 series	
3621	£1795
3651	£1595
3652	£1959
3653	£2595
3654	£2999
PRINTERS	
Oki Microline 80	£329
Epson Mx80	£399
Oki Microline 83	£749
Anacom 150	£699

INTECOLOR 3621
Standalone desktop computer with color graphics, 13" CRT; Deluxe 117 Key Keyboard including color and numeric clusters plus 16 special function keys; File Handling DISK BASIC and FORTRAN Languages 32 lines, 64 characters per line. Built in 50K byte Micro-Disk drive. 32K of User RAM and User Manual.

INTECOLOR 3651
Complete desktop computer with color graphics, 12" CRT; 101 Key Keyboard, including color and numeric clusters; File Handling DISK BASIC; 32 lines 64 characters per line. Mini Disk drive with 80K bytes storage including bus expanded interface and 16K.

INTECOLOR 3652
Same as 3651 except has 160K byte Dual Mini-Disk drive

INTECOLOR 3653
Same as 3651 except has 591K byte Dual 8" Floppy Disk drive.

INTECOLOR 3654
Same as 3651 except has 1182K byte Dual 8" Double Headed Floppy Disk drive.

INTECOLOR 8000 Series

Dyad Developments are now able to supply the full range of INTECOLOR 8000 series desktop computers and terminals

SPECIFICATIONS

13" or 19" colour display with 80x48 or 80x24 characters and 180x192 point resolution graphics in 8+8 colours. Disk storage from 80k to 1.9M Bytes, or 13,26MByte hard disk. Powerful disk operating system in ROM or CP/M on 8060 series computers. Also available is a Very High Resolution Graphics option with 384x480 individually colourable points of 8 possible colours. Includes software for point plotting, vector drawing in a variety of line styles, automatic labelling and scaling of grids and axis, bar charts & pie charts, multiple curve plotting, circles and markers, automatic polyson fill, text justification, both 2D & 3D modes, rotations, clipping and lots more.

PRICES

8001G	19" colour terminal	£1579
8001I	terminal with high resolution option	£2699
8051	colour computer with 90k disk storage	£2621
8052	colour computer with 180k disk storage	£2939
8053	colour computer with 590k disk storage	£3645
8054	colour computer with 1180k disk storage	£4275
8063	cp/m based computer with 980k disk storage	£4229
8054	cp/m based computer with 1960k disk storage	£4849

contemporary cabinate (as in picture) for 8000 series systems add £120.00

ALL PRICES EXCLUDE VAT AND CARR/ P&P

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TANGERINE

microtan 65

£69

Microtan 65 is the most advanced, most powerful, most expandable microcomputer available —it also happens to be the most cost effective.

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TANEX—£43
IK 16 parallel 1/0 lines. Cassette Interface—1 serial 1/0 line. 2 x 16 BIT counter timers OPTIONS TK RAM total—32 parallel 1/0 lines. 4 x 16 BIT counter timers—RS232. 20MA current loop.
10K MICROSOFT BASIC—£49
System Rack—£49 in black/tangerine in brushed aluminium.
Full Ascii Keyboard with numeric pad—£60.85. Cabinet available—£20. Lower Case option—£9.48.
Chunky Graphics Pack—£6.52. Tanram Full Memory Expansion to 40K—£119.00. Mini Motherboard—£10.00.
Cassette with counter—£21.70.

"I have given TANGERINE five bonus points for getting just about everything right"—E.T.I. Mag., May 1980.

COMMODORE PET

Everything has been said about PET—Britain's number one selling microcomputer. A full range of accessories and software, (both games and business), is held in stock.

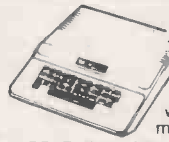
£399

8K Inbuilt Cassette—£399,
8K Large Keyboard—£425
16K Large Keyboard—£499
External Cassette—£55
Dual Disc Drive—£695
Tractor Printer—£395

CASSETTE SOFTWARE: Strathclyde Basic Course, Basic Basic Course, Invaders, Treasure Trove of Games 1 to 10 (10 selections of games), Basic Maths, Algebra, Statistical Packs and lots more!

apple

£599



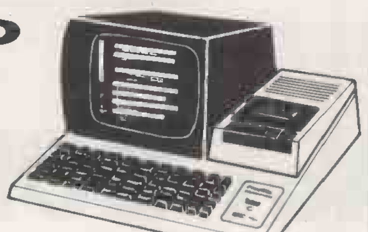
The Apple II + is more powerful than its predecessors with built-in sound and high resolution graphics, which make it ideal for scientific and games applications.

APPLE 16K—£599
APPLE 32K—£649
APPLE 48K—£659
Epsom Printer—£349

Cassette with counter—£21.70
Disc drive without controller—£299
Disc drive with controller—£349
16K add-on—£69

CARDS: Prototype/hobby card—£15, parallel printer interface card—£104, communications card—£130, high speed serial interface card—£113, Pascal language system—£299.

SHARP



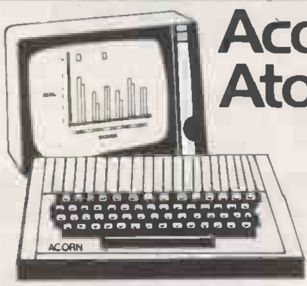
MZ80 20K	£449
36K	£475
48K	£495
Printer	£475
Dual disc drive	£715

video genie system

The Video Genie system has many uses in all spheres of life, the easy to use BASIC language means that programmes are easily written for specific applications, and pre-recorded programme tapes are available in great variety. TRS/80 software can be used with this system. The system has great scope in the home, sophisticated games programmes can introduce the computer age to all the family, who can then progress to writing their own programmes in BASIC or even machine code. Software is continuously being developed to aid home budgeting and education.

£299

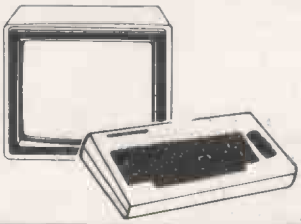
Acorn Atom



The ATOM is a British-designed personal computer—simple to operate, and in kit form, simple to build. It has all the features found in machines twice the price or more, and yet it has one outstanding advantage. It is designed on an expandable basis.

Atom kit 8K ROM 2K RAM ...	£ 120
assembled ...	£ 150
kit 12K ROM 12K RAM ...	£ 220
assembled 12K ROM 12K RAM ...	£ 250
1K RAM set ...	£ 9.50
4K Floating Point ROM (included in 12K version) ...	£20.00
Printer drive ...	£ 9.00
LS244 buffer ...	£ 2.50
Colour encoder ...	£19.00
Mains PSU ...	£ 8.00

COMMODORE VIC



Commodore International Ltd. (AMEX-CBU) has officially introduced the world's first full-featured colour computer priced at under £200.

The new VIC 20, which retails at £199.00 was unveiled on January 8th at the Consumer Electronics Show in Las Vegas.

The new computer puts Commodore squarely in the low priced personal computer market with a fully expandable microcomputer which connects to any television set and rivals the features of existing microcomputers selling at four or five times the price. The features speak for themselves:

- colour • sound
- programmable function keys
- 5K memory expandable to 32K
- standard PETBASIC
- full-size typewriter keyboard
- graphics character set
- plug-in programme/memory cartridges
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BASIC COMPILER and PROTECTION FEATURE for COMMODORE machines

THE COMPILER

DTL-BASIC is the product that every Commodore user has been waiting for (but probably thought was impossible). Just look at these features:

* programs run up to 20 times faster (depending upon the nature of the program and its size)
* almost totally compatible with the Commodore Basic Interpreter
* no arbitrary constraints; if the program runs on the Interpreter then it can be compiled
* large programs when compiled can occupy significantly less store
* provides true integer arithmetic (as well as real arithmetic)
* compatible with almost all assembler routines
* the compiler accepts extensions to Basic
* compilation speed is 1·2 lines/second
* encourages well documented programs that are easier to understand, debug and modify

DTL-BASIC gives you the best of both worlds; you can develop programs on the Interpreter and then compile them to get an amazing performance improvement. Compiled programs can only be retailed with a Software Vendor license.

THE PROTECTION FEATURE

DTL-P-BASIC is the same compiler as DTL-BASIC with the addition of an outstandingly secure protection feature incorporating multiple levels of protection to deter the most determined 'Pirates'. Protected programs will only run on specially protected disks supplied by Drive Technology Ltd.

Available now on 3000 range, July for 4000/8000 series

DTL-BASIC Compiler Software vendor license	£300 (manual £15, Update service £100) price on application
DTL-P-BASIC Compiler (including a copy of DTL-BASIC and a Software vendor license)	£900 (manual £15, Update service £200)
Protected disks	£100 for a box of 10 (quantity discounts available)

PRICES INCLUDE VAT

Please state machine configuration when ordering.

DRIVE TECHNOLOGY LTD 318 RINGWOOD ROAD, FERNDOWN, DORSET; BH22 9AT. TEL. 0202 64 5819

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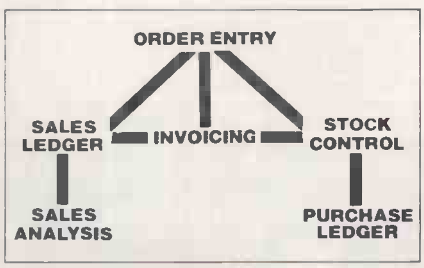

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An interlinked suite of programs forming an advanced wordprocessing and communications system which facilitates the creation, manipulation and distribution of text simultaneously around an organisation with offices in different locations

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METROTECH

WORD PROCESSING

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WORD-STAR 2	£255/£30
WORD-STAR 2 with MAILMERGE	£315/£40

NEW * Commercial Operating System * NEW

At last a secure commercial environment can be created under CP/M. COSY offers a **true COBOL compiler,** ISAM files, enhanced disk I/O, screen formatting and printer spooling. Requires Z80 or Z80A processor.

COSY — including COBOL compiler	£450
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FDUMP — utility file dump	£30

One manual for all the above £15.

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Written specially for the U.K. market, Version 2.0 of GRAFFCOM'S Integrated Small Business Software is now available for both floppy (ISBS-F) and hard (ISBS-W) disk systems. Modules available are: Payroll, Company Sales, Company Purchases, General Accounting, Stock Control, Order Entry and Invoicing, Name and Address, Time Recording, Lease, Rental/HP. Prices are available on request, discounts quoted for bundles of the above systems. Manuals **£35** each.

LANGUAGES/UTILITIES

CBASIC II COMMERCIAL DISK EXTENDED BASIC	£75/ £20
SBASIC COMPILER STRUCTURED BASIC	£175/ £30
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MET/TTY	£95/£15
I/O Master Board	£225/£20

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Change the disc and your Electronic Assistant becomes a word processor. It will help with proposals, contracts, reports, documents, price-lists, mailing and all those other wordy office tasks.

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Your Electronic Assistant will keep a file of personnel, pupils, properties, patients. Find what you want, when you want it. Match people to jobs, children to schools, buyers to houses, patients to treatments. Retrieve files and print information at the touch of a button.

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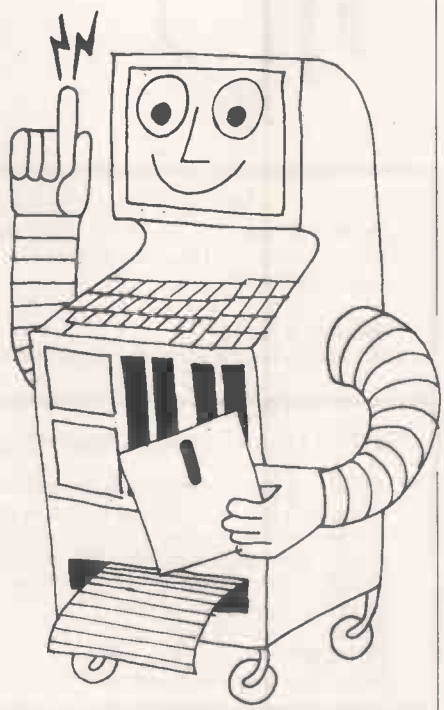
And of course your Electronic Assistant will help mind your business. Send bills, keep accounts, process orders, take stock. Give you time to look at the business information you've never had time to analyse properly.



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Digitus specialises in microcomputing, communications and the electronic office. The Company provides complete systems for the small business, professional practice and large organisation. Costs vary between £3,000 and £30,000 per system depending on facilities. We acquire software packages and equipment from all over the world to satisfy requirements and have the capability to put machines and software together, adding the special features you need.

• Circle No. 153

What price software?

PART OF OUR editorial stock-in-trade is an ingenious comparison between the impact on the software business of the micro and the impact on the book business of the first printing presses. To recap, for the benefit of those readers who have not followed the story so far: before Caxton, books were made very slowly, by hand, in monasteries for very rich men who could not read. That is very like the way software used to be written: very slowly, by hand in applications houses for rich men who knew nothing about computing. The printing press arrives and in the time it takes a scribe to do an illuminated "A", Caxton can run off three or even four whole pages.

Before very long, Caxton has a heap of finished books in the corner of the workroom and is wondering how much to sell them for. Over the centuries, a solution has evolved and now we know how to price a book. Of course, the problem is made easier because a book is a substantial object: the paper, the printing, its storage and transport to the reader all cost large and determinable amounts. What is in question is the return the author and the publisher should receive for their intellectual investment in the book.

With software, the position is rather different: the whole thing is apt to be intellectual investment — the cost of the disc, manual and postage can hardly amount to £10 while the whole package is apt to be offered for £20 — £100 — £1,000 Well, which? That is the problem.

One way to calculate the price is to take the cost of writing the package, add 100percent for profit and divide the total by the number of copies you expect to sell. This, however, just puts the problem further back. How many do you expect to sell? It is a bold man who will put a figure to that, especially if he is trying to sell a piece of software of general — or so he hopes — appeal. By guessing too low, he might make his price so high it will never sell; by guessing too high he makes his price so low that the few he actually sells do not pay his costs.

Yet, that is probably the wrong approach altogether. The important man here — where is he not? — is the customer. He cares not one fig, jot, iota, or button what it cost the package's perpetrators to write it. He judges it only by its usefulness to him. He might argue: I pay my secretary £2 an hour and this word-processing package will let her type 10 hours less a week so my annual saving is £1,000 so I should expect to pay the capital sum on which £1,000 pa is the interest, viz: £5,000.

Is that how he argues? Of course he does not. Let us return to buying a book. Our customer — or "you" for short — walks into a bookshop and fingers the goods. You look at the cover, the publisher, the lies that he has printed on the back jacket, you flip through the pages, sample a few of the author's well-chosen words and then you part with the trivial amount of money demanded.

The buyer of software is in a rather different position. He can not really obtain any idea of what he is buying by looking at the disc. The manual may be totally misleading. It might be beautifully written, immaculately printed and totally wrong. It may be smudgy, badly laid-out, unindexed but the software it describes is so good you do not need a manual anyway. Yet even if you have the opportunity to run the software in the privacy of your home, you often cannot really tell whether it is going to be worth the month's work growing accustomed to it will entail. If you decide it is — well, here is a blank disc — why not just copy it and save everyone good deal of trouble?

To cope with these uncertainties, the customer tends to apply some very crude rules of thumb. He seems to say things like:
"£90? Far too cheap. Not worth bothering about".
"£150 — £300 — why not"?
"£500 — I'll think about that".

Now, one can sympathise with anyone who does not want to spend £1,000 on anything, but why reel back in horror from cheap software? Marketing folk-lore tells us that if you halve the price, you sell five times as much. However, the tribulations of low-cost software in our business tell us that this is not necessarily the case.

Even so simple-minded a fellow as our mythical buyer has discovered that an essential, invisible part of any software package is a soothing voice on the end of a telephone which explains why Minnie, your office mouse, made the whole thing crash just by looking at it.

That soothing voice is apt to cost the software perpetrator about £10,000 a year and for some reason emerging folk wisdom has decided packages that cost less than £90 will not make it. Yet VisiCalc originally cost $70.

The whole problem is confused by the Americans who will insist doing things first, cheapest and loudest. Other things being equal, what relationship should we look for between British prices and U.S. ones? They have about four times the population and that would suggest that their prices ought to be one-quarter of ours to carry the same overheads. Yet if one is to believe the evidence available, people in Britain are twice as likely to be interested in microcomputing as they are in America, so that our real population is only half theirs, and their prices ought to be about half our prices.

Whether by design or accident, that is what we see: with the dollar about half the value of the pound, products often have the same numerical costs in Britain and the U.S. While this is satisfying to the theorist, it makes the entrepreneur's job rather difficult. He cannot confine himself solely to the U.K. market. With America's huge installed base of micros and lavish spending power, he must try to enter that market. It is however, all uphill. Not only does he have to sell 3,000 miles away, he must do it on returns which are only half as great per unit as he would receive in the U.K.

Of course, the volume of the U.S. market ought to work for him just as it does for native producers, but the cost of entering it is that much greater. To make matters still worse, he probably has to contend with the chauvinism of most of Middle America.

To work the American market properly, one almost certainly needs an American base. Keeping and supervising a body several thousand miles from home is an expensive and uncertain business: operating through loose links with American firms is equally risky.

What we need is a concerted national push. Products like Rolls Royces, whisky and tweed get the benefit of national prestige advertising to persuade Americans that of such stuff is heaven made. Something similar ought to be done with British software. Americans ought to have it firmly impressed on them that though they have many fine qualities, they ought to leave the delicate business of programming to their older and subtler cousins. The new computing age is one where the literature, laws, customs, habits of our time have to be transcribed on to silicon. While the thrusting dynamic of the new land may be very good at making hardware, it needs a more civilised spirit to breathe life into it.

The object of the exercise is to flatten out the marketing hill: to persuade the Americans that British software is worth paying a premium for. If we do not somehow manage this — perhaps in the last resort by actually writing better software than they do — our micro industry is going to be swamped in just the same way that our film, aerospace, book publishing, electronics industries have been. It is a great shame in a way that the Americans did not — as they so nearly did in the 1870s — choose German as their national language. If they had, Germany would have all the aggravation of the "special relationship", while we could get on quietly with our own lives.

Our Feedback columns offer readers the opportunity of bringing their computing experience and problems to the attention of others, as well as to seek our advice or to make suggestions, which we are always happy to receive. Make sure you use Feedback—it is your chance to keep in touch.

Censure for Sinclair

I WAS intrigued to read in Feedback, April 1981, that Commodore U.K. is "selling Pet updating ROM sets below cost price" as a gesture to good customer relations. It is good to know that someone in the industry is interested in good customer relations: there must be many customers like me who absolutely loathe Sinclair.

Following strong advertising in the sunday press, I ordered a Sinclair ZX-80 earlier this year for £100. "We want you to be satisfied beyond doubt", said the advertisement "and there is a 14-day money-back option, of course".

The machine arrived in the second part of February and although it was fun, I had in the meantime discovered your excellent magazine and it did not take long even for a novice like me to realise what the ZX-80 lacked. Imagine my disbelief, however, in reading an advertisement in your April edition for the Sinclair ZX-81, a much-improved machine, at £70.

I immediately asked for my £100 back — so that I could purchase a ZX-81 — but the 14-day period had just expired. "We have every sympathy", said Sinclair and: "We regret we are unable to offer a discounted 8K ROM to existing ZX-80 owners, nor can we offer a part-exchange facility since, as you will appreciate, this would create a precedent".

What kind of business morality is this, to push outdated stock on to unsuspecting customers at nearly 50 percent more than the new model which is about to become available? You can imagine the enthusiasm with which I now view my Sinclair.

If there were more of us, we could have a riot, but as it is, I can only vow never to touch a Sinclair product again and suggest to as many acquaintances as I can that they might be wise to do the same.

P D Austwick,
Bath.

In praise of the ZX-81

HAVING drawn attention to the limitations of the Sinclair ZX-80 — Feedback, June 1980 — I feel I must now give due credit for Sinclair's most recent achievement in the computer market.

I refer, of course, to the ZX-81. I have recently bought one of these remarkable units for my own personal use, and also to assess its suitability for schools use. I can state without reservation that the ZX-81 is everything the advertisements claim — and more.

Certain specific points which may be of interest to readers:

- The construction of the casing is considerably more sturdy than the ZX-80, i.e., it does not fold if you squeeze it.
- The touch-sensitive keyboard has a finish far superior to the plastic-sheet finish of the ZX-80 keyboard.
- The manual is exceptionally well written, and very informative.
- I have experienced no problems at all in recording and playing back programs using a moderately-good cassette recorder.
- The moving graphics are very good, and give far more scope for games.
- The screen display is very good and totally flicker-free in slow mode.
- Using a function key, all keywords and functions are input by single-key inputs, plus Shift or Function for some — a great saving of time and storage.

I would have no hesitation in recommending the ZX-81 to any of my pupils, or their parents who are interested in a low-priced computer for personal use. Any comment on suitability for general school use would be a little premature at this stage, beyond saying that without the 16K expansion module, scope for school use would be limited.

Having visited the Acorn laboratories and seen something of developments on the BBC computer, it is clear that — for three times the price — the BBC Proton offers considerably more than the ZX-81 in terms of storage, facilities and expansion potential. It seems to be an excellent unit. For home computing power per pound sterling, though, the Sinclair ZX-81 is going to be hard to beat.

Graham Blackwell,
South Brent,
Devon.

Logical languages

I WOULD first like to say that I found Raymond Anderson's article on Pascal, May, 1981, most interesting. On the whole, I believe that it contained some very useful constructive criticism, which could be borne in mind by the software houses. However, I feel that Anderson has put little thought into some of his criticisms.

For example, concerning the case-statement default which he thinks is non-existent. True — there is no simple way out, but then, is it not one of the main intentions of structured languages — especially Wirth's brainchild, Pascal — to promote the logical approach?

The logical answer obviously involves set instructions: declare all the case alternatives as members of a scaler type, i.e., declare a universal set at the beginning of the program, then just before the case statement, discover if the case operand is not in the universal set, i.e., using IF/NOT(IN/) THEN/ ELSE (Case)). It is longer, but default is not lacking, and in most situations the set version makes more sense.

May I take the opportunity to thank you for a great computing magazine, but please, can we have more articles on languages, like Micro-Pascal and Algol 68? While I am about it, I would dearly like to learn more about Lisp — books are so expensive.

James Morgan,
Skewen,
West Glamorgan.

Raising finance

YOUR interesting editorial, *Financing the Future*, May 1981, creates a sour taste in the mouth. The inability to see beyond the end of one's nose is not, I regret, confined to the Government. I am running a virtually-unfunded charity which deals with many hundreds of Vietnam refugees. One of our aims is to establish an efficient charity and thence to create jobs. Our initial dialogue with the Manpower Services Commission suggested that we might be able to obtain money to research unemployment but none to create any solution.

More to the point, in this case micro-computers, I believe that the comparatively small investment of a few £1,000 would provide us with the basis of efficient economic management and the opportunity to find employment for people whose English may not be up to normal employment standards. If and when I can raise some money, I will need to find a secretary; I would prefer a person from Vietnam both because one language barrier would cease to exist and to lower the horrific 90 percent unemployment which exists within this group.

A good word-processing program, for example, would enable our secretary to produce standard letters in reasonable English. The ability to produce and save letters without having to correct reams of paper could provide real help in English improvement.

Financial programs could help to solve the perennial problem of finding capable bookkeepers — a problem so noticeable in small and large charities alike. My experiences in working for commerce and

(continued on page 44)

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(continued from page 42)

in three charities have taught me that even the sometimes inadequate standards of financial management found in commerce are often lacking completely in charities. Already a number of local charitable organisations have expressed interest in the possible use of a microcomputer with multi-user facilities.

Sufficient dynamic and static RAM would provide us with the opportunity to compile the extensive medical statistics which could help solve the many stress-related illnesses that constitute the "Refugee Syndrome". The interest shown by the MSC in research-orientated projects could then produce the cash to staff a medical research and help program.

Finally, we wish to set up a co-operative to provide employment for the many skilled people whom we are trying to assist. The range and number of possible uses is extremely large. The problem arises when one tries to raise the cash to buy such equipment; those with the money to give to such causes tend to regard the micro as a kind of games machine. I can see the means of providing employment, creating wealth for the country, building a self-supporting charity which serves a community of many thousands and rebuilding the self-confidence and esteem of a homeless and lost people.

Roy Tindle,
The Community of Vietnam,
Erith, Kent.

Alternative history

I AM compiling an alternative history of computing. The history will focus on the lighter side of the development of the subject, highlighting the failures, the accidental discoveries, the legend both famous and infamous that have helped to share the present-day state of the art. My address is 996 Warwick Road, Acocks Green, Birmingham.

I would be grateful for any help in the compilation of this work and any contributions in the form of, say, press cuttings, references and personal recollections would be most welcome.

Martin Wakeman,
Acocks Green,
Birmingham.

Protecting software

WITH REFERENCE to the late Lawrence Perry's interesting discussion on the use of patents and copyright in the protection of computer software, April 1981, I would like to add a further possibility.

While it might be harder to implement the following approach in connection with disc-stored programs. I can see no reason why it might not offer immediate protection to program authors in connection with cassette-based material.

The idea is to resort to the protection offered under copyright law to pieces of music. Since a cassette tape — whether containing a program or a piece of Bach — can be played audibly on a simple machine found in almost every home, and since the definition of music is largely culture-dependent — but still protected, even when the culture is far from the local norm — why not declare each cassette-recorded program to be a piece of music?

Any attempt to copy it, for whatever purpose, would be an infringement of copyright invoking a well-established legal procedure for recovery of compensation.

I would be interested to hear from anyone who has started to take this approach.

Nick Laurie,
Langport,
Somerset.

CP/M documentation

I AM glad to hear that Rose Deakin — *Practical Computing,* April 1981 — is managing to overcome the documentation problems of CP/M. I can, however, assure her that when she progresses to MP/M her earlier problems will seem like the joys of spring.

Having recently taken delivery of an MP/M package, I was surprised to find that documentation on CP/M 2.2 was supplied with it. Then I found that the manual MP/M mainly describes the differences between CP/M and MP/M; in other words, MP/M is just the same as CP/M — except, of course, where it is different.

My favourite quotation is found on page 11, where it says: "See the Digital Research document entitled, CP/M 2.0 Users' Guide for CP/M 1.4 Owners, for a detailed description (of MP/M)", Referring to the CP/M documentation supplied is not all that helpful either. For instance, page 2 of the CP/M 2.2 Users' Guide refers to the reader already being familiar with CP/M 1.4.

I have just one message for Rose Deakin and others who find themselves bewildered or confused — ask. Do not be afraid of appearing foolish, it happens to all of us sometimes. I am not referring to any particular supplier, but to any supplier whose documentation is inadequate.

We are the customers for whom the manuals were written and they should intelligible to us.

Roland Couvela,
Farnham,
Surrey.

Revolutionary storage

BRING personal computing out of the dark age. I have discovered the ultimate storage medium — a medium which can boast unsurpassed reliability, while being highly cost-effective, totally portable, requiring no special handling or storage precautions and easily and compactly stored. This medium can be read and written at different speeds without fear of reliability loss by virtue of a synchronisation signal.

Comparing paper tape to cassettes and floppy discs, you can see that, in price at least, paper tape is the clear winner:

Medium	Storage Capacity	Cost	Cost/ Kbyte
Paper-tape	120,000 characters /roll	£1.50	1.28p
Cassette at 300 baud	21,600 characters /tape	£0.55	2.61p
Floppy disc density-single formatted	82,944 charcaters /disc	£2.90	3.58p

Clearly, from the table, paper tape beats all its competitors in price per memory unit.

I hear the sceptics saying that paper tape is slow, but slow compared to what? A popular machine like the Pet has a tape-transfer rate of 500 baud which is, effectively 250 baud since all data is recorded twice. The Teletype 43 runs at 300 baud.

Yet cost is not paper tape's outstanding asset. Paper tape has almost 100 percent reliability. My last four reels of paper tape have had only three parity errors — an error rate of 0.00625 percent or one part in 160,000.

TTY Knox,
Hull,
Humberside.

Micros in medicine

I WOULD be very pleased to hear from anyone who has any ideas or information about using microcomputers on general hospital wards for teaching or management.

I own a Sinclair ZX-80 with a 16K RAM pack and would like to be able to put it to use when I teach in the ward.

I realise that the Fluid Monitor as packaged by Medicom may soon be leading the field in intensive-care units and I feel that any means of improving nursing care and teaching with the use of microcomputers would be a welcome step forward.

Valerie Garland,
Plymouth.

Course control

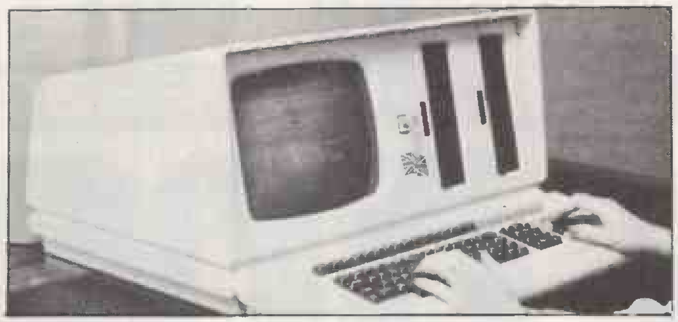
I AM interested in locating packages, suitable for running on a microcomputer system, which are designed to control the bookings of places on courses and conferences.

The system would effect control from the first point of contact — an unconfirmed booking — through to the preparation of invoice data following a candidate's attendance on a specific course. Ideally, such software should interface directly with a compatible invoicing/ledger administration package.

If there are no proprietary packages available, perhaps someone could offer me their opinion of the suitability of a tailored hotel reservation, front and back office, system/billing system — such as is offered by Landsler, for example. I can be contacted at 20a Worley Road, St Albans, Hertfordshire AL3 5NS.

N J Williams,
St Albans, Hertfordshire.

LSI's M-Three aims at professional market



A NEW British microcomputer has been launched, aimed at the top end of the personal-computer market. The M-Three is the latest offering from LSI Computers of Woking in Surrey. The microcomputer cost around £1 million to develop, with one quarter of the money funded by a Government grant.

LSI already manufactures two computers, the M-One and the M-Two at its two factories in Woking. A third factory is under construction and when it is completed, the M-Three will be leaving the production line at the rate of 150 computers a month.

The manufacturer claims that the new machine offers more ability, storage and user-satisfaction per pound cost than any comparable machine available. The machine is Z-80 based, has 64K RAM, two double-density mini-floppy drives, a VDU with 1,920-character green phosphor display and a full-function keyboard. The keyboard has 14 programmable function keys, and a numeric pad making a total of 109 keys.

M-Three is equipped with a CP/M operating system and is programmable in Basic and Cobol. There is also a range of applications software available from LSI computers. The complete package costs less than £3,000 without software, or £3,500 with one LSI software application included for small-business users.

There is a standard option of two 8in. double-density floppy-disc drives replacing the mini-floppies. With this configuration, the system will cost £4,000 with and £3,500 without software. Printer interfacing is simple and there are two RS232 interfaces available for extra printers or VDUs.

The machine specification and price have been carefully geared to market needs and the manufacturer is confident that the machine will be a success.

LSI managing director Tom Fitzpatrick has this to say about the company marketing operation: "Our plan is to become one of the major suppliers of high-ability personal computers by 1982. We see the greatest market as the grey area at the top end of the personal market and the very small end of the business market.

"For example, typical customers would be professional people requiring computer power for their own work, small business proprietors, scientists, engineers, schools and colleges".

LSI Computers, Copse Road, St Johns, Woking, Surrey, GU21 1SX. Telephone 04862-23411.

Stars of the Pet Show

THE Commodore Pet Show, West Centre Hotel, Lillie Road, London, June 18—20 features a number of innovatory products for the Commodore range of systems. The Commodore Vic-20 has finally made its U.K. public debut.

The Vic-20 is a full-colour computer costing less than £200 and its launch has been eagerly awaited. Commodore, has, however, had problems in producing enough to meet the expected demands from the U.K. market and in adapting the computers for use with British television. Commodore officials are still confident that they will be able to sell 100,000 Vics by the end of the year.

CP/M enthusiasts, or Pet owners who have long been frustrated by their inability to use the vast range of software written under the CP/M operating system, will be heartened to learn that a CP/M adaptor for the Pet, launched at the Pet Show, is now on sale. The CP/M "stunt box" costs £550 and plugs into the IEEE interface on the Pet. An optional RS232 port costs an extra £20.

The software for the device was written by Keith Frewin of Unicorn who then had the "box" developed by Derek Rowe of Small Systems.

Second-hand equipment

A BECKENHAM-based concern has launched a microcomputer system to buy and sell new and second-hand micro equipment. Kelly's Computer Market uses two Apples to store details of equipment for sale and wanted.

Buyers and sellers are matched by price, area, machine type or whatever category the subscriber wishes, on a program written by the firm's managing director, Gordon Kelly. Weekly cost of the service is £2.50 plus VAT.

Used equipment attracts a special discount — one month's subscription covers inclusion until the equipment is sold. The service is free to buyers. Contact Kelly's Computer Market, Paragon House, Beckenham, Kent. Tel: 01-659 7997.

Government outlines strategy for national teletext campaign

MICHAEL Marshall MP, the Parliamentary Under Secretary of State for Industry, has announced that October is to be National Teletext Month. The aim of this will be to promote the sales of TV-based entertainment and the teletext information service. There will be prizes for consumers and the retail trade.

In a speech given to the Scottish Congress of the Radio Industries Club at Gleneagles, Marshall said: "Government is supporting industry to establish rapid consumer acceptance of teletext within the home market, with consequential benefits to prospective imports of software, hardware and know-how.

"While there should be no Government-led market creation, we can assist by serving as a focal point for industry to initiate increased marketing activity, as well as helping to develop a Teletext promotional campaign, aimed directly at the consumer".

He went on to outline this strategy which would include:

- Provision of consumer material to aid understanding and encourage trials of teletext.
- Public-relations activity.
- Sales-training schemes for shop-floor staff.
- Trade incentives for shop-floor staff.
- Seeking further support from other areas of the teletext industry.

"As a culmination of these and other marketing activities", Marshall continued, "the Government is to sponsor a Teletext Month this October with support and co-operation from each of the industry sectors involved. It is proposed to run a national consumer competition during October designed to encourage consumer trials with teletext TV sets and adaptors as prizes. A trade competition would also be run for showroom staff with regional and national prizes for the best showrooms".

Cynics point out that if giving away teletext sets is not Government-led market creation, not to mention the rest of the strategy, then nothing is.

Plessey makes micros

PLESSEY, the U.K. electronics and telecommunications giant, is to manufacture microprocessors. By choosing a licence deal with Mitel, Plessey has made a significant break with its previous policy of in-house process development.

Mitel is a Canadian company which already has similar deals with British Telecom and GEC and was chosen because of its Iso-CMOS process which is among the most advanced available today.

Four software additions to VisiCalc family

PERSONAL Software, the company responsible for the best-selling VisiCalc program has developed four more packages in the same vein. Like VisiCalc, probably the most-used microcomputer program in the world today, the four new products will be available for most of the popular brands of microcomputer.

The new programs include VisiPlot, a high-resolution plotting and graphics package; VisiDex, a flexible personal information system; VisiTrend/VisiPlot, a combination of the VisiPlot program together with a program for time-series manipulation, trend forecasting, and descriptive statistics.

The VisiTerm program allows a personal computer to communicate with a wide variety of other machines ranging from large mainframes down to other personal computers.

There is also a new version of the original VisiCalc program available for the Apple II and the Apple II Plus computers. The enhanced VisiCalc is compatible with Apple's 16-sector disc storage format and includes 17 new commands and operations to make numerical model-building on a personal computer easier still and even more powerful.

The four programs as well as the new VisiCalc program have the ability to pass data between programs. For example, files created using VisiCalc can be transmitted to another computer via VisiTerm. Files generated by data input using VisiCalc can be used to provide graphical output when transferred to VisiPlot.

There are now a total of seven programs in the Personal Software VisiCalc family, all providing functions vital to the successful management of a business. The software can be used as a suite or the programs used individually by people without any specialised knowledge of computer programming.

The new software is not yet available in the U.K. but for those wishing to buy direct from the U.S., prices are as follows; VisiDex $199.95; VisiPlot $179.95; VisiTrend/VisiPlot $259.95; VisiTerm $149.95. Personal Software Inc. 1330 Bordeaux Drive, Sunnyvale, California 94086.

Programming as a cottage industry

IN HIS book, *The Wired Society,* James Martin predicted the revival of cottage industries. Rather than the traditional weaving, or lace-making activities, however, the cottage industrialist of the future would be a computer programmer. Jeremy Hope, the managing director of Ram Computer Services, hopes to prove James Martin right.

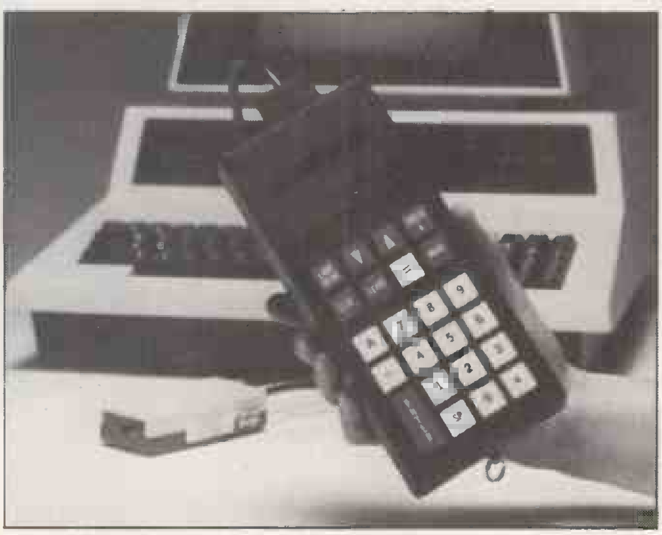
Ram Computer Services' project will, if successful, begin the process of emptying the dp departments of Britain, reversing the trends of the past 200 years. Ram is not looking for just anybody, though — they want experienced, professional programmers to provide business users with first-class custom-designed packages.

The programmers will work in teams, supervised by Ram to ensure that the work meets the high standards required and in part to save programmers from wasting time exploring blind alleys. They will work on machines leased or purchased from Ram, and the scheme will be of special interest to redundant programmers who want to invest their redundancy monies in something which could provide them with a future.

Jeremy Hope, the instigator of the scheme says of the scheme: "We expect the opportunity to have wide-spread appeal as work can be undertaken at any time of the day or night they choose. Moreover, after a year of working for us, programmers will be in a position to purchase their own computer, which, who knows, could form the base of an autonomous business operation".

If you are interested in the scheme, contact Jeremy Hope at Ram, 15-17 North Parade, Bradford 1, West Yorkshire. Telephone 0247-391166.

This neat hand-held terminal from MSI Data International is called a data capturer. Developed by Mektronic Consultants of Manchester, the device known as the TermiPet can be used for the remote entry of data using the keyboard or wand scanning of bar codes. When the Pet is not busy, the data stored in the TermiPet memory is transferred direct to the Pet via a cable connection. From the Pet, the data is transferred to either disc or cassette for immediate or future use. The particular configuration is a MSI-77 with 4K memory, the interface and software either on disc or cassette. The terminal has a double back-up system of batteries to ensure no loss of data. The TermiPet system is available for the 8000, 4000 and 3000 series of Commodore equipment. Prices of the TermiPet system start at £795 plus VAT. For further information contact Catlands Information Systems Ltd, Harrison Building, Green Lane, Wilmslow, Cheshire. Telephone 0625-527166.

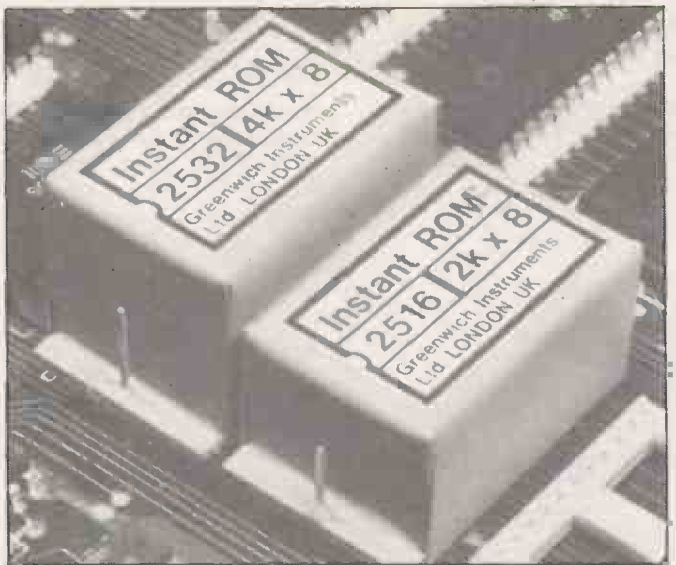


More powerful Aim 65/40

THE enhanced version of the Rockwell Aim 65 single-board microcomputer has been unveiled in London. The Aim 65/40 still uses the evergreen favourite 6502 eight-bit microprocessor from MOS Technology, which means that there will be a degree of compatibility between the two systems.

The Aim 65/40 at about £900 has an on-board thermal printer just like its predecessor, and a full 65-character keyboard. There is a strong resemblance between the two machines but the new model has more integrated circuits as well as a larger display and printer — 40 characters instead of the previous 20.

There is an ample 65K of on-board storage and the configuration of PROM, ROM, and RAM is user-selectable. Portable Microsystems Ltd, Forby House, 18 Market Place, Brackley, Northamptonshire NN13 5SF. Tel: 0280-702017.



Instant ROM is two or four kilobytes of CMOS memory with battery back-up which can be plugged into any standard ROM/EPROM socket, or in the ROM-expansion sockets of the Pet or similar microcomputers. Once inserted it may be used like RAM. The difference is that when the system is turned off, the program stays. Programs can be edited or altered immediately, without erasure problems, yet once entered, the program will remain as if it was stored in ROM. The real advantages of the device are apparent when it is used to write security and utility programs. Since typical battery life is six years, the programs are not likely to disappear very fast. Instant ROM costs £39 for 2K and £56 for 4K inclusive. Contact Greenwich Instruments Ltd, 22 Bardsley Lane, Greenwich, London SE10 9RF. Telephone 01-853 0868.

MicroCobol adherents to form user group

MICROCOBOL does not seem to have dominated the pages of *Practical Computing* in the past, but apparently the language seems to set some people's pulses racing. In fact, so keen are some that they have banded together to form a distributors' and users' group.

At the inaugural meeting of the new group, certain resolutions were passed. The first stressed the support and enthusiasm of the group for the Business Operating System and the MicroCobol Development System and all the associated products produced by CAP Microproducts Ltd.

The meeting decided to "encourage further exposure which will result in substantially-increased use of the products". Finally the group proposed to work closely with the CAP organisation "to ensure that this British software product is grown throughout the world".

Meanwhile CAP has let the MicroCobol division split from the main company. The new company will be known as Microproducts Software Ltd and will be essentially the same company as before but with a different name.

Anyone wishing to apply for membership of the MicroCobol users' group should contact the chairman Bob Muston on 0533 28256.

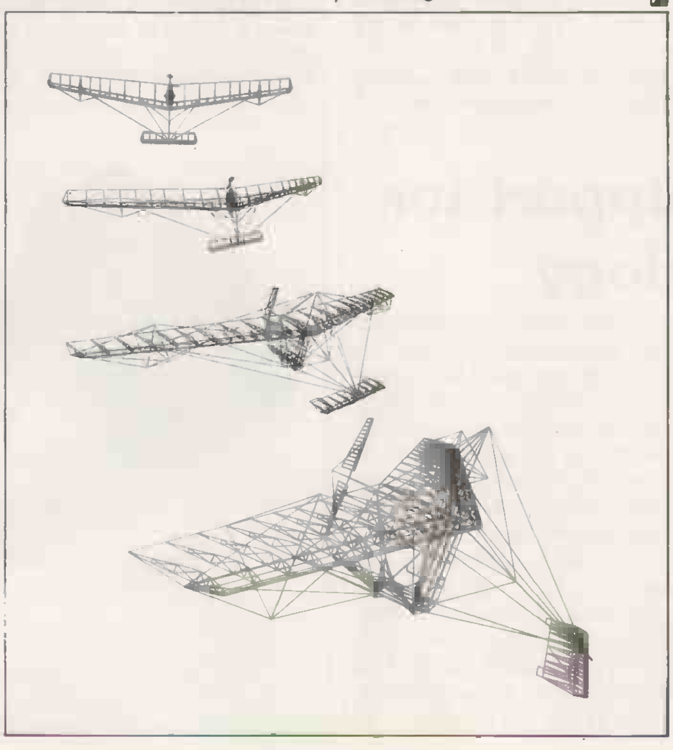
Software range will draw HP-1000s into world of graphics

HEWLETT-Packard's new Graphics/1000 II software for use on the HP-1000 range of computers will provide the support required for a wide range of graphics peripherals. Additionally, the resources are now available for more advanced uses such as three-dimensional and interactive graphics which lead to sophisticated computer-aided design applications.

The available software will initially comprise two packages: the device independent graphics library, DGL, and the advanced graphics package — 3D, AGP-3. The DGL package is a collection of programs which will enable the users of different graphics peripherals to use a common set of commands. Alone, the package will support only two-dimensional graphics.

However, the second package will expand the capabilities to support three-dimensional, interactive graphics applications. The software is styled to complement the Hewlett-Packard range of graphics peripherals.

The graphics library weighs in at £1,082, and the three-dimensional package represents a considerable investment at £2,164. Hewlett-Packard is at King Street Lane, Winnersh, Wokingham, Berkshire. Tel: Reading 61022.



The future of Nascom at Lucas Logic

THE PURCHASE of Nascom by a subsidiary of the Midlands engineering giant Lucas Industries ends months of uncertainty regarding the British microcomputer manufacturer's future. The buying company, Lucas Logic, has promised to retain the Nascom name and product range.

Dealers and users of Nascom equipment will no doubt be happy about the deal as it ends for them a period of rumours and false starts. For Lucas, the deal brings them into the small-microcomputer market for the first time.

The new owner of Nascom is a newcomer to the personal-computer scene, but Lucas has been involved in computing since 1977. The management of Lucas Logic see the purchase of Nascom has a natural extension of the company's activities in computer applications for industry.

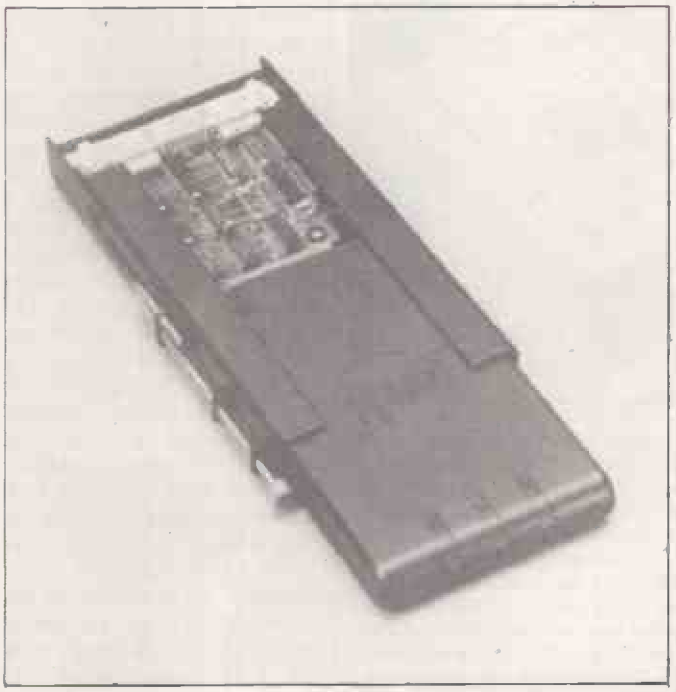
In addition, it will give the firm a comprehensive and proven range of products, varying from the "starter kits" suitable for educational and hobby users to the high-performance micro and minicomputers for small business and industrial use.

The new address of Nascom is care of the headquarters of Lucas Logic at Welton Road, Wedgnock Industrial Estate, Warwick. Sales will continue through the existing dealer network.

Intel develops removable bubble-memory cassettes

A COMPACT storage medium which can operate in a harsh environment is likely to be of real benefit to microcomputer users who do not have, say, the advantages of air conditioning. Intel has developed a system of removable bubble-memory cassettes which is designed to be a flexible building-block. The Plug-A-Bubble system allows users to configure systems in a variety of ways.

The basic iPAB system consists of a 128Kbyte capacity bubble-memory cassette and holder. There are two optional building-blocks available, a 5¼in. chassis, housing two cassette holders and an iSBX bus interface card with cabling. Individual cassettes are also available.



If 5¼in. sounds familiar, it is because the Plu-A-Bubble system is designed to fit in the same space as a mini-floppy unit. The iPAB cassette is housed in a rugged cast-aluminium cartridge and it contains the Intel 7110 one-megabit bubble-memory, together with the 7220 controller and other support chips. Up to two cassettes can be incorporated in each chassis and can interface with the standard Intel iSBX Multimodule bus.

Each cassette has an average access time of 48 milliseconds and a data transfer rate of 12.5Kbytes per second. The tough case can withstand a shock of 40g. in three axis. The cassette will operate in the temperature range of 0 to 55° centigrade. The power requirement is a standard +5 and +12 Volts, power consumption eight Watts per cassette.

Typical applications of Plug-A-Bubble include those involving the capture of data such as test instrumentation, telecommunications and data-aquisition terminals and in industrial machine or process control. The system is of particular use in applications where the device needs handling or constant transportation.

To obtain the current product price reflecting local billing factors and availability, contact Jacques Brunet at Intel Corporation, Rue du Moulin à Papier, 51, Boite 1, B-1160 Brussels, Belgium. Telephone: (322) 660 30 10.

Financial support for high technology

A RECENTLY-established company has been formed to provide industries in the high-technology sector with the specialised financial support they need. New Technology Finance is highly selective in choosing the companies it will support, tending towards those concerns which have been established for some time and show considerable promise, yet need additional finance to cope with expansion.

New Technology Finance has a board whose expertise combines technical, financial and commercial skills and the directors use their knowledge to link clients with potential sources of finance. Another service of the company is to monitor the progress of the client company to the benefit of both client and investor.

Interested companies are invited to contact the managing director of New Technology Finance Ltd, Mervyn E Smith at 27 Old Bond Street, London W1X 3AA. Tel: 01-643 9234.

Extra products to suit Apple

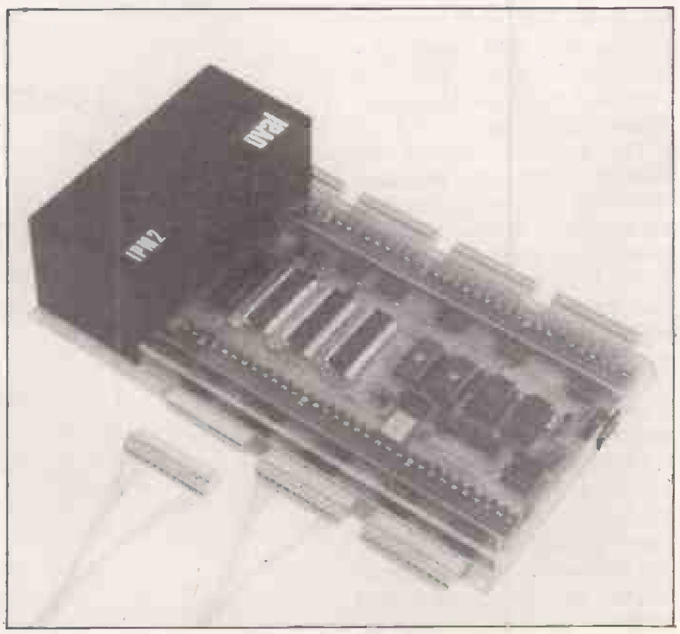
U-MICROCOMPUTERS is a British-based manufacturer of microcomputer accessories based in Warrington, Cheshire. Competing with imported products, mainly from the U.S., the first item in the U-Microcomputer catalogue is a 16K memory card. The U-Ram-16 is compatible with the Apple Language card, but costs less than half the list price of the imported article.

The U-Ram-16 allows Pascal programs to be run, makes 56K — as opposed to 48K — available to CP/M programs, gives VisiCalc 35K rather than 25K to play with, makes the integer Basic ROM card obsolete and can be used with the new Hayden Applesoft Compiler.

The card retails at £130 assembled or £99 as a kit, plus VAT. Discounts are available for volume purchasers. The card is available direct or through the nationwide Apple dealer network and has a one-year warranty against defects.

U-Microcomputers can be found at Winstanley Industrial Estate, Long Lane, Warrington, Cheshire, WA2 8PR. Tel: 0925-54117/8.

This, the new 32-channel Industrial Plant Interface from Oval Automation, is a self-contained, single-board unit and can be connected to the host computer via a serial RS232 link. Although primarily designed for the Apple microcomputer, the IPM-2 can be used with any computer which has a serial port. Alternatively, the unit can be used as a stand-alone device with the instructions contained in EPROMs. The cost of this device is £295 and further details can be obtained from Oval Automation Elm Park, Ferring, Worthing, Sussex, BN12 5RN. Telephone 0903-44831.



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The C8001 is an 8 bit Z80A* system with up to 256 Kbytes of memory for 1-5 users. And is easily expandable to the more powerful 16 bit C8002 configuration, with 256 Kbytes to 1 Mbyte of memory handling up to 8 users.

Based on the Z8000* processor, the C8002 may be connected to a high speed local network for further expansion.

Industry compatible versions of COBOL, PASCAL, BASIC, CBASIC2*, FORTRAN and C are available on OASIS*, CP/M*, MP/M* and UNIX* operating systems. Also available are packages for communications, data base management, word processing and business applications.

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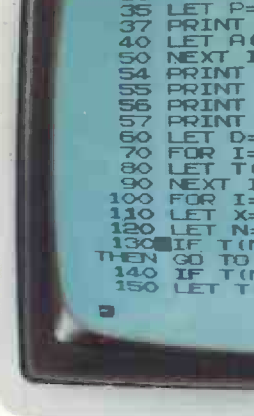


New! Sinclair ZX81 Personal Computer.

Kit: £49.95 complete

Built: £69.95 complete

Reach advanced computer comprehension in a few absorbing hours

1980 saw a genuine breakthrough – the Sinclair ZX80, world's first complete personal computer for under £100. At £99.95, the ZX80 offered a specification unchallenged at the price.

Over 50,000 were sold, and the ZX80 won virtually universal praise from computer professionals.

Now the Sinclair lead is increased: for just £69.95, the new Sinclair ZX81 offers even more advanced computer facilities at an even lower price. And the ZX81 kit means an even bigger saving. At £49.95 it costs almost 40% less than the ZX80 kit!

Lower price: higher capability
With the ZX81, it's just as simple to teach yourself computing, but the ZX81 packs even greater working capability than the ZX80.

It uses the same micro-processor, but incorporates a new, more powerful 8K BASIC ROM – the 'trained intelligence' of the computer. This chip works in decimals, handles logs and trig, allows you to plot graphs, and builds up animated displays.

And the ZX81 incorporates other operation refinements – the facility to load and save named programs on cassette, for example, or to select a program off a cassette through the keyboard.

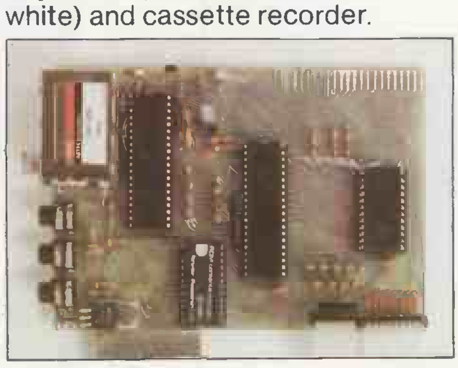
Higher specification, lower price – how's it done?
Quite simply, by design. The ZX80 reduced the chips in a working computer from 40 or so, to 21. The ZX81 reduces the 21 to 4!

The secret lies in a totally new master chip. Designed by Sinclair and custom-built in Britain, this unique chip replaces 18 chips from the ZX80!

Kit or built – it's up to you!

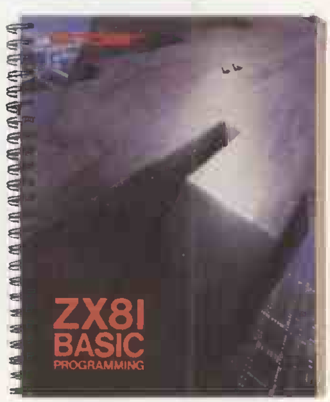
The picture shows dramatically how easy the ZX81 kit is to build: just four chips to assemble (plus, of course the other discrete components) – a few hours' work with a fine-tipped soldering iron. And you may already have a suitable mains adaptor – 600 mA at 9 V DC nominal unregulated (supplied with built version).

Kit and built versions come complete with all leads to connect to your TV (colour or black and white) and cassette recorder.

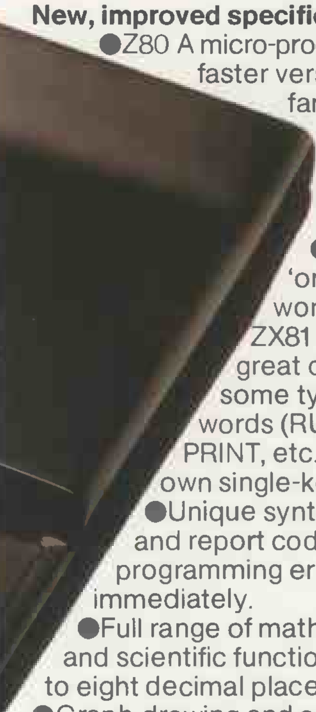


Proven micro-processor, new 8K BASIC ROM, RAM – and unique new master chip.

New BASIC manual



Every ZX81 comes with a comprehensive, specially-written manual – a complete course in BASIC programming, from first principles to complex programs.



If you own a Sinclair ZX80...

The new 8K BASIC ROM used in the Sinclair ZX81 is available to ZX80 owners as a drop-in replacement chip. (Complete with new keyboard template and operating manual.)

With the exception of animated graphics, all the advanced features of the ZX81 are now available on your ZX80 – including the ability to drive the Sinclair ZX Printer.

Coming soon-the ZX Printer.

Designed exclusively for use with the ZX81 (and ZX80 with 8K BASIC ROM), the printer offers full alpha-numerics across 32 columns, *and* highly sophisticated graphics. Special features include COPY, which prints out exactly what is on the whole TV screen without the need for further instructions. The ZX Printer will be available in Summer 1981, at around £50 – watch this space!

16K-BYTE RAM pack for massive add-on memory.

Designed as a complete module to fit your Sinclair ZX80 or ZX81, the RAM pack simply plugs into the existing expansion port at the rear of the computer to multiply your data/program storage by 16!

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How to order your ZX81

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	Mains Adaptor(s) (600 mA at 9 V DC nominal unregulated).	10	8.95	
	16K-BYTE RAM pack(s).	18	49.95	
	8K BASIC ROM to fit ZX80.	17	19.95	
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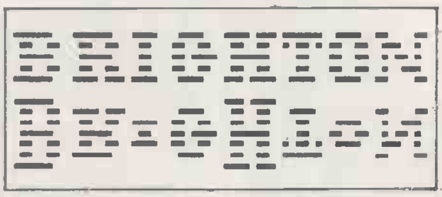
Art for Prestel's sake

COMPUTING may be an art, but can Art be done on a computer? To be specific, on Prestel? It is by no means an obvious application. The Prestel screen is formatted in such a way as to maximise the transmission of "hard" information — and graphics are effectively in a supporting role. The 40-by-24 screen is limited and entering graphics codes to build "pictures" is fiddly.

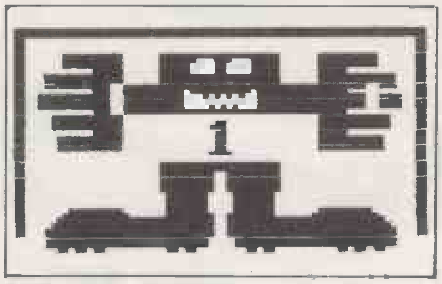
There are also some restrictions on the use of colours for pictures — we are discussing pictorial art — caused by colour-control characters. Nevertheless, the strong colour saturation and hard

by Martin Hayman

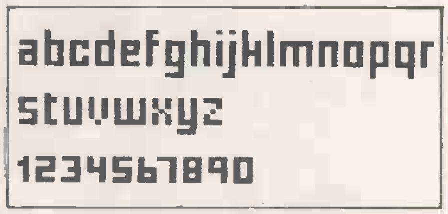


Reflex Brighton by Clive Chizlett.

Planet in eclipse by Clive Chizlett.



The goalie by Mark Johnson.



Alphabet by Mark Johnson.

edges represent an obvious challenge to the artist who wishes to make a silk purse out of a sow's ear. Ralph Steadman's *Emotionally-drained squid on holiday* for example is recognisably Steadman but undoubtedly 40 by 28.

Brighton Polytechnic has risen to this challenge and last month presented, in association with Brighton-based Viewpress 444, "the world's first Viewdata art exhibition". Curiously, it was the department of graphic design, under Clive Chizlett, rather than the large and effective computing department, which took most interest in the topic.

Though Brighton's computing department has taken a lead in videotex and education with its espousal of the schools telesoftware project — see *Practical Computing* Printout, June — this was intended as an exercise in exploring the visual possibilities of the medium.

In the first place, it was intended to run an international competition but this did not make the starting line for shortage of time. In the event, the students in the group had less then two weeks to learn the keyboard and the tricks of the trade, so it was not altogether surprising that several of them found the most interesting avenue of approach was to design a satisfactory typeface, some of which I reproduce here. These are doubtless a useful contribution to the Prestel repertoire though one doubts their usefulness in a commercial Prestel operation.

Clive Chizlett argues that legibility is demonstrably an aid to comprehension and hence perhaps to saleability; to the idle flicker-through of the Prestel database, this may be so. At the moment, much of Prestel is used for sheer wodges of information but as it becomes more and more part of the well-equipped household, there will be a greater premium on attracting the browser rather than the seeker.

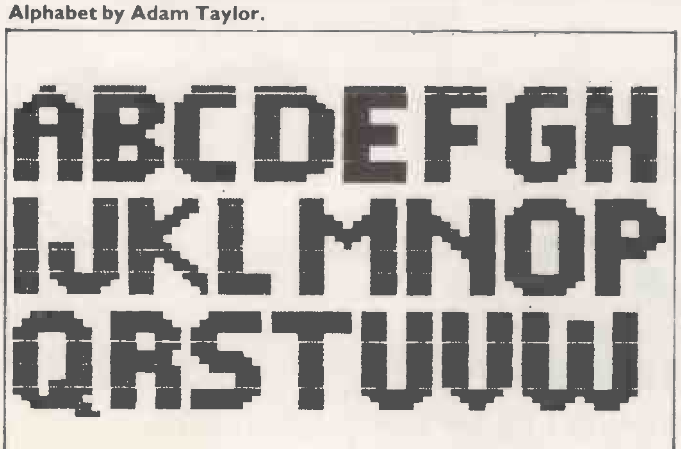
Chizlett also sees room for a Prestel study into the partially-sighted, for whom Prestel offers a means of communication, but he feels it would require resources — intellectual and financial — outside his range. He would not feel qualified, he indicated, to "measure" quality of sight, which would need researchers, qualified in psychology.

As for the exhibits, I must confess to a slight disappointment. Much of the best work came from foreign exhibitors, notably the Germans, who have a school dedicated to the exploitation of the medium. I saw no further work from Steadman, who had certainly whetted my appetite for further pictures. One interesting feature of Steadman's *Squid* is the routine developed by IP Mills and Allen to get continuous vertical colours. Unless you can do that, pictures are practically impossible.

The constrictions of blank colour-control characters also make the design of serifed character faces fiddly, though the raster thrown up by the Techs machines which Viewpress 444 uses are an inestimable boon in any kind of Prestel screen design.

Will it catch on? It is certainly an intriguing exercise, but with picture Prestel just around the corner, which will cater for mail-order and other product-type displays, and with the current sophistication of inexpensive, dedicated graphics-orientated machines, I think it may prove something of a blind alley.

Alphabet by Adam Taylor.



Chinese Dragon by Clive Chizlett.

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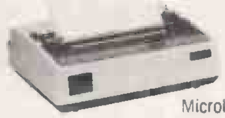

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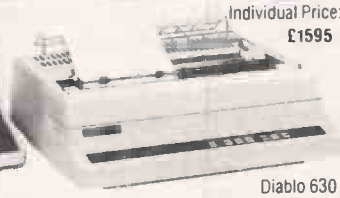

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Twinning schools and business

DAVID FAIRBAIRN, the director of the National Computing Centre and I were discussing the ideal programmer who is — in my view — a 17-year-old who writes code like unrolling a carpet. Developing this theme, we were musing on the fact that most of the people in the U.K. who thoroughly understand micros but have little hardware on which to work are in their teens and in school, while the people who have micros, badly need to understand them but do not are middle-aged and in business.

"Why not", we said as one, "bring the two together"?

That is what we propose. Schools with a stock of programmers but little hardware should be twinned with businesses which have a stock of hardware and a supply of problems. The twinning will, initially, be arranged through a register kept at the *Practical Computing* offices. As suitable schools and businesses apply, we shall introduce them to each other.

What might happen in practice? We imagine that it could be well worth a firm's while to set aside two afternoons a week when the computer would be used by people from the school. They would expect to help with the business problems that must arise, but at the same time, they would have their own programs to run. "Could you write a little package which re-formats the stock-control file so the word processor can use it"?

"What about a program to calculate whether it's better to buy widgets FOB Rotterdam at the warehouse door in Galashiels"?

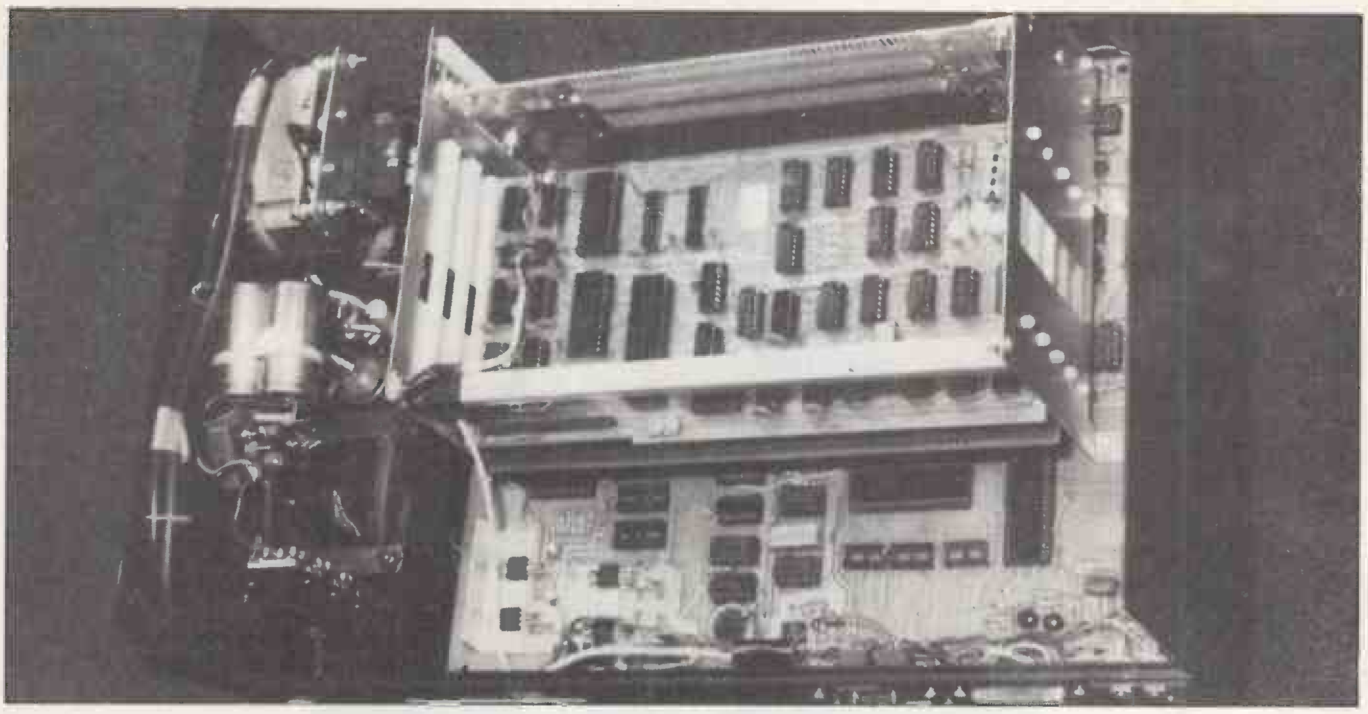
No doubt, as the young helpers make themselves useful around the place, the amiable proprietors will want to reward them suitably. Happily there is not yet an honourable Corporation of Master Programmers to shout "foul" so it is possible that everyone might be able to proceed in a mutually-convenient way. Possibly, the association will lead to the writing of major software packages in the school holidays: if that happens, it can only be to the good.

What, on the other hand might go wrong? Well, the young visitors could be a nuisance. For this reason, we think it is necessary that the link is made officially to the school so that discipline can be applied. A child who makes a pest of himself can be controlled through the school's computing organisation.

If everyone involved is to stay sane, access will have to be controlled.From the school's point of view, it would want to be sure that the youngsters are not being exploited. It would be no part of the project to provide labour for keying in the day's invoices.

The success of a twinning will depend a good deal on the give and take of both sides. If you are interested, let us know. Write to: Twinning, *Practical Computing* Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS.

Peter Laurie



Through the expansion jungle with intrepid Explorer

THE EXPLORER 85 microcomputer system is a low-cost, 8085-based system manufactured in the States by Netronics Research and Development Ltd. The system is designed to be used at a series of levels which provide the user with a logical and well-mapped route through the jungle of system expansion. In its final, fully-developed form, the Explorer is a powerful little machine suitable for a wide range of serious programming tasks.

The powerful 8085 processor from Intel is fully software-compatible with the 8080 and is faster by about 50 percent. That means any program written in 8080 code can be implemented on the Explorer and will execute faster.

The review Explorer system consisted of a series of modules cased in an attractive blue cabinet which lends the system a no-nonsense, business-like air. These sturdy, steel cases are available as an optional extra to those who build the system from scratch and certainly do something to inspire user-confidence.

Compactness

A striking feature of the Explorer system is its compactness; the component parts of the system are a main system cabinet, a rather neat little video monitor, a disc unit, and a ASCII keyboard as well as the CP/M system disc.

The first task, having unpacked all the boxes, is to arrange the component parts on a desk or table and to assemble them. The main system box is the largest component and has three buttons on the front and some switches on the back. The back of the case also has a RS232 port and some jack sockets as well as a number of terminals, one of which was intriguingly labelled "loudspeaker".

A logical method of constructing and proving the system seemed to involve testing the main part of the system before connecting the floppy disc unit. Verifying the main system soon proved to be simplicity itself — the system components just plugged into each other. All too often when reviewing microcomputers, they fit together well enough, but when the machine is switched on, nothing happens.

by Bill Bennett

Happily, the fan inside the main cabinet began to hum. When the monitor is turned on, the usual patchwork of a memory dump is displayed on the screen. The next move is to press the re-set button on the front of the main cabinet. The computer will now boot — that is, the memory is cleared and the computer will go to the beginning of the monitor. The Explorer now sits in limbo until an input is received from the keyboard.

The input the Explorer is expecting is a signal to set the baud rate automatically; the machine will operate at any baud rate between 110 and 9,600. The monitor contains a routine which looks for the particular input — in this case, a constant depression of the space bar. The routine then calculates the baud rate accordingly.

Once the rate is set, the signing-on message is displayed on the screen and programming may begin. There was no Basic interpreter in the review Explorer, so at this level, the programming is entirely in 8085 machine code but to make life easier for the user, some monitor commands are provided.

Connecting the floppy-disc unit did not present any major difficulties. Before connecting the disc unit to the main system, and before inserting a disc, it seemed a good idea to check the disc unit worked. The floppy disc manual recommends that the voltage readings on a certain chip are checked first, and having had bitter experience of wayward disc drives in the past, I followed that advice. The voltages appeared to be correct.

Deceptively simple

Next was the deceptively simple-sounding task of connecting the disc to the main system. To perform this task, you must remove the two screws on the rear of the cabinet, swing the top of the lid forward and lift it out. With the lid off, it is a comparitively easy task to plug in the disc-connector ribbon cable.

I should, however, point out at this stage that once the disc unit is set up it should not be moved too often — the disc controller board sits on a cradle inside the main system cabinet, and every time the disc cable is removed there is a disconcerting flex in the controller card. The manual suggests a blank disc is first loaded to test the head-load and release commands. Not having any blank discs handy at this stage could result in much grief later.

Now the big moment arrives — the loading of the system disc. The Explorer system utilises the 8in. floppy discs which, apart from inspiring confidence in the user with their more business-like appearance, hold far more information than the smaller, 5¼in. version.

Re-set button

The re-set button on the front of the main cabinet is pressed and the re-assuring sound of a solenoid clicking informs the user that the disc is being read. After a short wait, which can be nerve-racking if the disc contains expensive software, the system replies by displaying the signing-on message on the video monitor. The machine worked, and gave a good account of itself.

Since the Explorer uses the CP/M disc operating system there is a wide range of applications software available and there is no reason why an Explorer, possibly using two or more disc drives, should not be used in a commercial application. Its compactness and smartness certainly make it a desk-top microcomputer which would not look out of place in the office of any businessman.

One of the best features of the system was the video output — there was very little of that annoying screen flicker which can strain the eyes. The picture always appeared to be sharp and bright. The video monitor supplied with the system can be bought as an optional extra, but considering one is required anyway, the Newtronics monitor at about £80 seems to be a wise and inexpensive purchase.

If the user is considering using the system as a business or personal computer then the ASCII keyboard is also an essential purchase. A less-expensive alternative for those more interested in control applications is the Hex keypad/display unit.

Unfortunately the Explorer has a shortcoming: it is a little prone to dirty supply current. This is only a small problem and is very simple to remedy but it can be a serious problem because of the consequences of the power supply being interrupted.

When a spike appears on the line — possibly caused by a motor being turned on — it causes the system to crash, which in turn damages any disc which happens to be in the disc drive at the time. To criticise the Explorer on this point might be a little unfair, though, since most microcomputers have the same problem.

The documentation supplied with any computer system provides the potential user with a valuable litmus to hold against the system. Good documentation does not always mean that the hardware is good, however, but if a company goes to a good deal of trouble to make sure that the documentation makes the user's life easy, then this helpfulness may be reflected in the product, and the support the company provides.

The documentation supplied with the Explorer was somewhat unusual but this may be due to the fact that as each level of the Explorer system is bought, the relevant manual is included with it. As stages are of differing degrees of complexity, the manuals are of vastly differing sizes. One possible solution to the problem would be to provide a ring binder so that each level can be added to the total, providing the user with one volume containing all the relevant information.

The level A manual is a little brief but it contains a parts' list and some reasonable assembly instructions. At first glance, this would appear to be adequate but many constructors would surely welcome a section devoted to trouble-shooting, especially considering the complexity of the project in question. The only help the bewildered constructer can seek is a price list which details factory trouble-shooting fees, and those are all given in dollars.

Machine code

Even so the level A manual contains a rather good section introducing the user to machine-code programming on the Explorer 85. This section is not aimed at the absolute beginner — anyone using it must understand Hexadecimal code, for instance.

I found it to be more than adequate and there is even a sample program fully-documented and talked through, providing anybody with an interest in 8080/8085 machine-code programming a useful introduction. The rest of the manuals, that is for levels B through to E,

(continued on next page)

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have a common thread in that they provided relevant parts' lists and good, clear assembly instructions.

There is the slight matter of the different sizes of the manuals, and their differing appearances, but this is a minor complaint. The manuals form a complete set and as such, would be more-conveniently presented in a ring binder. As supplements to these manuals, there are the Microsoft Basic-80 reference manual, assembly instruction sheets for the video board and the ASCII keyboard, cabinet assembly instructions and a Explorer-terminal ROM-user information sheet.

Overall, the documentation is adequate, in terms of information concerning the assembly of the system there are no complaints, but a trouble-shooting guide would be a great help. Some notes concerning the theory of operation of the system would also be desirable. Anyone seriously interested in system architecture would be strongly advised to buy a book on the 8085.

The promotional literature for the Explorer 85 makes great capital of fact that the system is expandable, and to quote the literature: "You're never forced to spend a penny for a component or a feature you don't require". This is the great advantage of the Explorer system.

The design philosophy behind the Explorer is based on the concept of levels. These levels are the backbone of the system and provide the user with a structured method of expanding the system. These units or levels are relatively inexpensive and the system can, therefore, be expanded as the user needs more computing power or as his budget allows.

The lowest level in the scheme is a single-board computer, the level A. The level A kit together with a video monitor, an ASCII or Hexadecimal keyboard, an RF modulator, and a suitable power supply, would provide the beginner with a useful introduction to programming.

The level B kit provides a S-100 bus expansion; level C is a card cage to accommodate up to six S-100 cards; level D provides the user with 4K of static RAM and level E is an EPROM expansion kit and also available is 8K Microsoft Basic in ROM or on tape.

The Explorer system then is capable of assuming many forms, for instance, a beginners' system, an OEM controller or a fully-fledged microcomputer system with four discs and running under CP/M.

Conclusions

- **The Explorer 85 is above all else a flexible little machine, available as a single-board kit or as a fully-fledged system, complete with discs, cases and CP/M.**
- **The CP/M operating system gives the user access to a very large range of software at reasonable prices.**
- **Construction of the system may prove to be far too difficult for the novice but should not prove too arduous a task for the more experienced and less faint-hearted constructors.**
- **The modular approach to expansion allows the user to let his system grow with his finances or requirements.**
- **The level A kit can be purchased for about £85, a 4K kit £327. Assembled this price would rise to £402 and the cases with cooling fans, etc., take the price up to £502.**
- **A RAM board is now available containing 16K of pageable memory.**
- **The Explorer 85 uses the 8085A CPU and is an S-100-based system.**
- **The Explorer 85 is marketed in kit and assembled forms by Newtronics Ltd, 255 Archway Road, London N6. Telephone 01-348 3325.**

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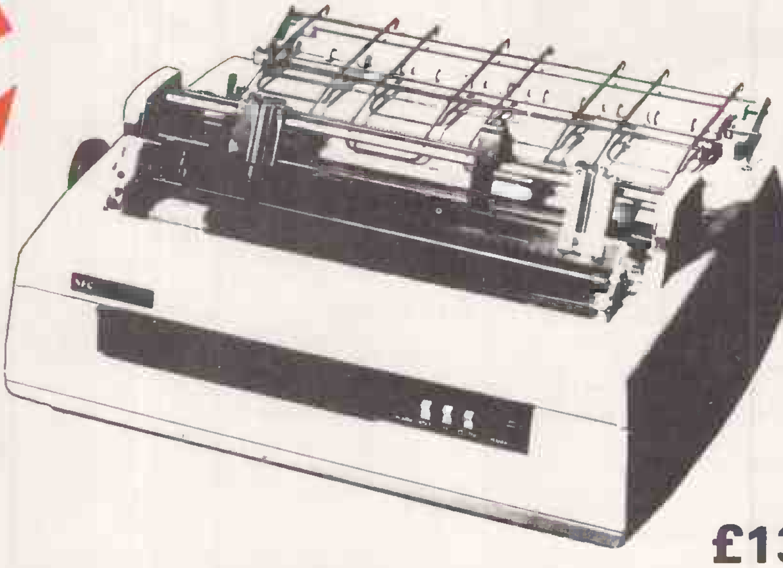

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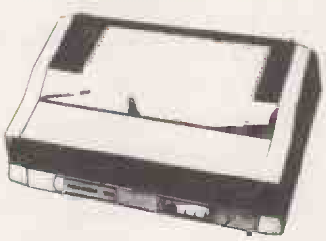

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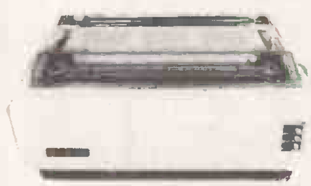

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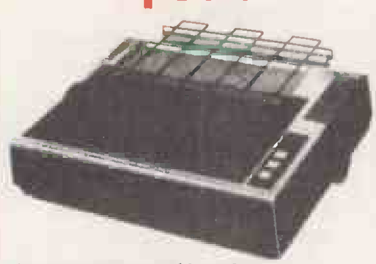

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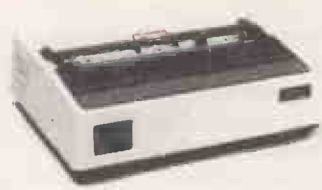

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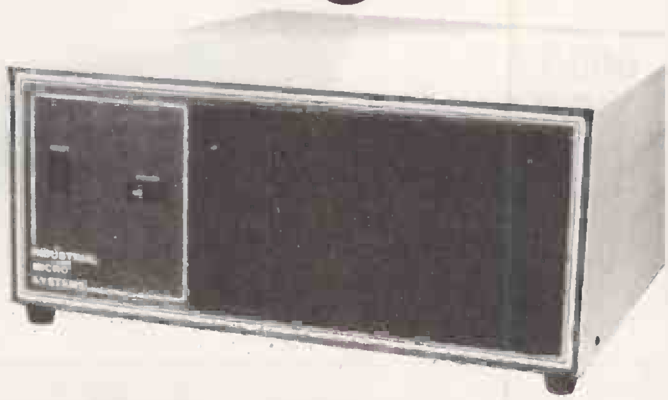

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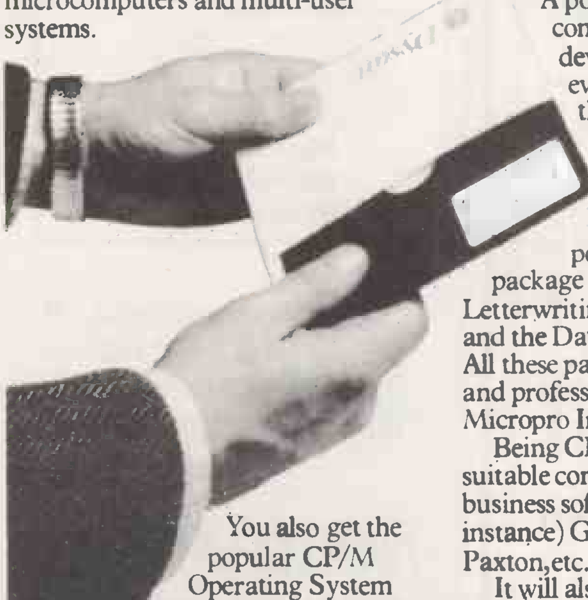

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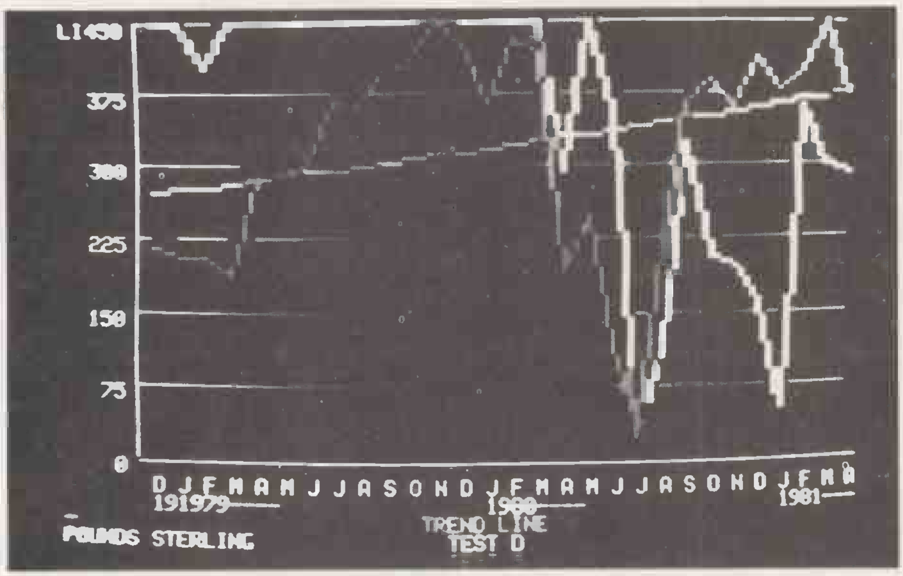
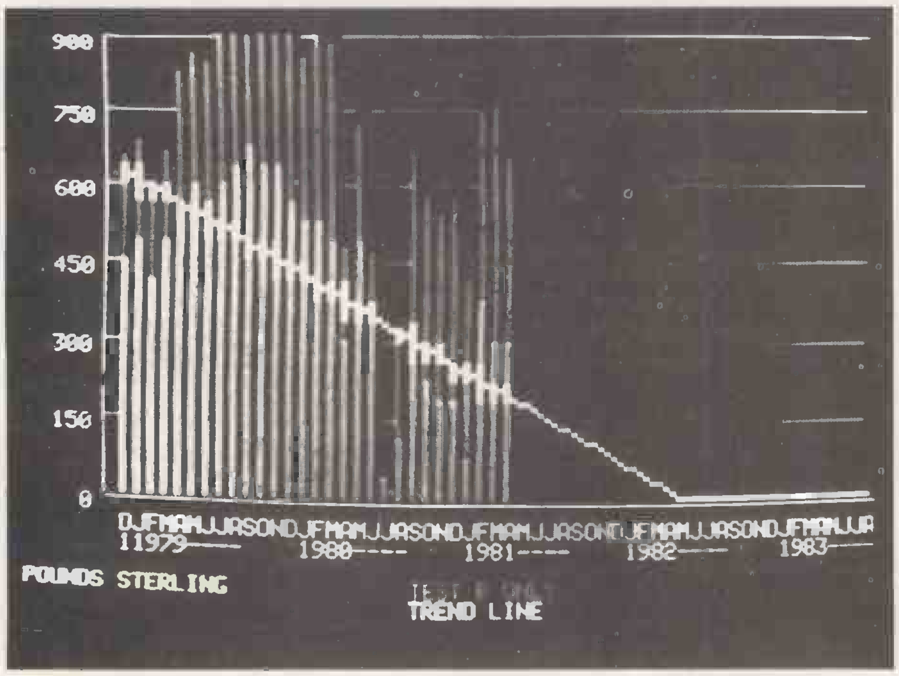
Putting a new complexion on micro graphics: Compucolor II





THE COMPUCOLOR machine was first launched in the U.S. in 1978 by Intelligent Systems Corporation and has been available in the U.K. since early 1979 from Abacus and now Dyad Developments Ltd of Great Milton, Oxfordshire. Dyad has been handling the Compucolor II in the U.K. for about a year.

The Compucolor II is in its second and third generation of development. The review system supplied to us by Dyad Developments was the Compucolor II with a deluxe keyboard and single floppy disc drive and Microline 80 matrix printer.

The Compucolor II is manufactured in the U.S. by Compucolor Corporation which is also linked with Intelligent Systems Corporation. Intelligent Systems Corporation also manufactures a similar machine called the Intecolor 3000 and

by Mike McDonald

8000 and has a long history of manufacturing colour micro-based systems. The Compucolor II population in the U.K. is currently in the low hundreds.

The system is supplied as a set of stand-alone units comprising:

- A 12in. colour monitor which also contains the peripheral controllers, central processor and power supplies.
- A single-density, single-headed floppy disc drive made by Siemens.
- A "floating" keyboard available in three models — standard, extended, and deluxe. The last two are optional and our version had the 117-key deluxe model.
- A Microline 80 serial dot-matrix printer. This was the printer supplied although the RS232 interface would be capable of driving any variety of Teletype printer.

Each unit is connected via ribbon cable to the printed-circuit-board edge connectors on the back of the colour monitor. The monitor and printer are each powered separately from the mains. There are three edge connector outputs on the back of the monitor: a 50-pin bus of no particular standard; an RS232C bi-directional serial output; and a keyboard/peripheral connector.

We found the connection of the disc drive unusual in as much as it had to be piggy-backed via a small printed-circuit card on to the keybord connection.

The disc drives for the Compucolor machine are all externally connected. The 3000 series has an integral, single floppy disc drive mounted in the colour monitor casing.

Our system was the model 5 with 32Kbytes of RAM, 16K of ROM and the disc drive provides 50Kbytes of on-line user storage. The Compucolor II had been modified with a microswitch to select

(continued on next page)

(continued from previous page)

upper/lower-case or upper-case/graphics characters from the keyboard.

With the system is supplied a 115-page programming manual, a 120-page maintenance manual, and a short instruction manual. The native language of the machine is a disc Basic 8001 interpreter which is ROM-resident. The Basic offers the following features:

27 statements: clear, data, dim, def, end, file, for, get, gosub, goto, if, input, next, on, out, plot, poke, print, put, read, rem, return, restore, step, then, to and wait.

Five commands: cont, list, load, run and save.

18 mathematical functions: abs, atn, call, cos, exp, fre, int, inp, log, peek, pos, rnd, sgn, sin, spc, sqr, tab, tan. All have arguments, i.e., tan(x).

Nine string-handling functions: asc, chr£, fre, left£, right£, len, mid£, str£, and val. each has various arguments, i.e. left£(a£,1).

The disc commands are: copy, delete, device, directory, initialise, load, print, rename, run, save, and write.

There is only a simple line editor function in Basic — re-type lines to replace or update. Erroneous input on a line may be deleted at the time of entry. An optional extra is a Basic text editor which is soft-loaded from floppy disc although we found the routines somewhat unwieldy. Routines included: move and delete — range — re-number, merge, compact — space removal — and rempac — rem removal.

On power-up, the machine moves immediately into Basic and allows the user to specify how many bytes are available for Basic memory. A null entry defaults to the maximum mounted in the particular model.

Dimensions	Width	Height	Depth
Cabinet	18in.	13.6in.	15.8in.
Keyboard	18.7in.	2.8in.	6.9in.
Weight — 37lb. including keyboard.			
Screen size — 13in. diagonal.			

Table 1.

The full-colour display monitor has 64 characters per line by 32 lines or 32 characters per line by 16 lines in large-character mode. The default on power-up is the large-character mode. The 64 ASCII characters are formed from a five-by-seven dot matrix and there are a further 64 special characters created from a six-by-eight dot matrix.

The screen can also be used in a 128-by-128 pixel graphics mode. We found the colours rich and of good quality but like all colour displays, some resolution is sacrificed when displaying small textual characters. While the upper-case characters were satisfactory, the lower-case characters were poor and hard to read. In graphics mode, the screen displays are of a very high quality but again, smaller-resolution fields become ill-defined.

The keyboard on our machine was most impressive. There is a central-pattern, standard QWERTY lay-out topped by two rows of special function keys, which include 15 user-programmable function keys, and sided by three blocks of separate keys — a numeric pad, a colour-select pad and an editing-function pad.

Most keys have two or three functions accessible through either shift, control or escape-sequence selection. All of the Basic reserved words are available as single keystrokes. There are plotting functions for the graphics mode and, of course, most of the control-code functions required for using this machine as a Teletype terminal on-line through the RS232 interface. In addition to this there are the 15 user-programmable function keys.

The programmable-function keys on the demonstration machine had been changed for those supplied with the word-processing package which we look at later. These alternative keys provided a variety of editing functions under the control of the word-processing software.

The colour-selection pad offered cyan, dark blue, black, white, red, magenta, yellow and green. Colours can be selected for use in either foreground or background mode. All colours are selectable under program control as part of the plot command.

There is a re-set key on the keyboard which causes the machine to enter 'CRT Mode'. In this mode, the Compucolor II may be used as a VDU through the communications port to other computers. The output baud rate may be keyboard-selected from any one of seven pre-set values ranging between 50 and 9,600 baud. There are two methods of re-entering Basic, one destructive to any program held in memory and the other non-destructive.

As well as full cursor control — right, left, up, down, and home — there is also an auto key which causes the first program on disc to be loaded and run — auto-boot function. We found the keyboard construction to be of very good quality and it had a light feel.

Initially, it might be somewhat confusing to the first-time user because of the number of functions available — a small price to pay for such a tremendous range of facilities. Sensible colour coding of batches of the keys helps to avoid confusion. The deluxe keyboard is likely to meet the requirements of any computer user whether a novice or expert.

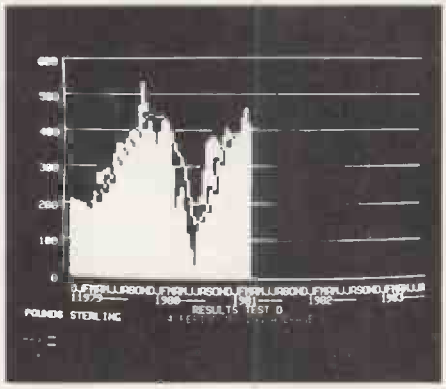
The disc drive was the simplest type we have yet encountered. It was a Siemens 5.25in. single-sided, single-headed unit. The disc format has 40 tracks and average access time is quoted as 400ms with a transfer rate of 76.8K bps. Total capacity is 51.2Kbytes per side. Compucolor recommends that users use both sides of a floppy disc simply by turning it over.

We felt dubious about this where the machine is likely to be used in a commercial environment unless the floppies are certified as double-sided. The drive is a box whose front is a flap which, when lifted, exposes the complete interior of the unit.

There is little to see other than the drive spindle and read/write head. Discs are placed into the mechanism; closing the flap makes it ready for access. The system occasionally had difficulty reading the disc loaded, but it usually succeeded after a re-try.

Some of the disc commands work from within Basic such as save and load. Others had to be entered under the control of FCS. FCS stands for File Control System and is a mode entered through a keyboard selection which forces an exit from Basic. From it, directories can be displayed and files deleted and handled.

The disc commands provided were adequate but we did not consider this aspect of the system very user-friendly. The disc directory displays comprehensive information but also gives the file sizes in Hexadecimal. Only some 15 pages in the manual were devoted to the disc system and file handling so there is room for



improvement — this is really more applicable from the programming viewpoint.

The disc error messages are unclear and are in the form of four-letter combinations. Basic is equally guilty in providing only two-letter error messages. The screen displays three lines of some amazing random fireworks when a file is deleted either manually or under program control. This was apparently the result of FCS using part of the screen memory as its buffer area.

The printer was a Microline 80 serial dot-matrix printer. There was no documentation for it but it seemed to be a compact and quiet printer with very good print quality. Our version was friction-fed and plugged straight into the RS232 interface port at the back of the monitor.

The Intel 8080 microprocessor acting as CPU has a two micro-second cycle time and the overall effect was that of a fast processor. The physical specifications for the system are given in table 1. The prices for the Compucolor II are listed in table 2.

The first of the two software packages we looked at on the Compucolor II was a data management and display system called Trendspotter. The package is a U.S. product for the Compucolor produced by Friend Information Systems of Boston.

The suite of routines allows users to create files containing relevant data or statistics for subsequent plotting in the form of line graphs, point plots, bar charts and further analysis of such data for trends and patterns. Application of the package is simple and it is intended to assist any operator to display data and develop a better understanding of the information content.

The package is supplied in the form of a comprehensive manual and two floppy discs — one program disc and one data disc. The software is a single program. Once it has been loaded, the program disc is dismounted and the data disc brought into use. The main menu offers:

1. Update file
2. Create a new file
3. Edit old file
4. Delete a file
5. Hard-copy printout
6. Directory of files
7. Change file name
8. Go to display program

Initially, data must be entered into a file for retrieval by the display program. Data may be periodical or independent — although the package is geared to analysis of data against a time base of months, quarters, or years. The create function prompts the user for a title of the data to be entered, the file name under which it will be stored, whether the data is monthly/quarterly/yearly, the starting date, and a units title.

Having completed this, the system produces a formatted screen and proceeds to prompt the operator for the data values against incrementing dates beginning with the start date. Each value is keyed until a null entry terminates the data input routine and the operator is then prompted for confirmation to write the file away.

Having created a file, it can then be displayed, edited and updated. The edit function displays the data dates and values on the screen and prompts for the entry of the date of the value to be altered and then its new value.

The update function permits additional values to be concatenated on to the end of the file at a later stage. The routines are easy to understand and use. Having entered a few files, the other main function is the display program, option 8.

The display program creates a blank graph format on the screen and awaits input from the operator at a prompt point on the bottom of the screen. Data files may be loaded into one of four work files in memory or into a common work area. Alternatively, files may be called for direct plotting on the screen.

Any file loaded from the disc is placed automatically into work area 0. From there, it may be saved into the other work areas numbered 1 to 4. If we had a file of values called EXPA, it could be plotted as a bar graph by simply entering BAR EXPA or the same result could be achieved by entered Load EXPA followed by BAR 0. In both cases, a copy of file EXPA is left in work area 0. The display is filled in with x and y axis values and descriptions and a bar plot is built across the screen in a suitably different colour from the background.

Trendspotter calculates the axis to fill the graph format and labels the display with the title of the file in the same colour as the plotted information. Further files may be plotted on to the same chart in different colours providing there is not too significant a change in the scaling factor.

The types of plot are: bar graph, line graph, scatter graph — point plot — area graph line graph with solid colouring of area under the plot, and nBar or multiple bar graph — several bar plots combined. Various types of the same data may be executed on the same display to find the most appropriate display method. The data may be further manipulated in the work files to provide some simple trend analysis. The options include:

Smooth: Calculates an exponential smoothing of the data in the 0 file and plots a line graph with the result. A factor of between .01 and 1 must be entered as the argument.

2Smooth: same as smooth except that it computes and plots a second-order exponential smoothing of the data in work file 0.

3Smooth: third-order smoothing.

Moving: calculates a moving average and plots a line graph. User must enter a value to indicate the number of periods for the calculation.

Trend: computes a linear-least-squares trend line and plots a line graph. An optional date may be entered to indicate the start point for the evaluation.

Etrend: computes an exponential-fit trend line and plots the result.

Ltrend: computes a logarithm-curve fit trend line and plots the output.

There are a further 33 commands for handling data, data files or making cosmetic changes to the display parameters. They can be entered as the first three characters of the command followed by any argument necessary. Many of the commands are useful but we found little occasion to use many of them.

The package does an excellent job of handling and displaying the data in a reasonable format. The user may plot as much information on any one display as can be digested and would appear to be a welcome aid for anyone whose job requires a considerable amount of forecasting with figures. The package is simple to use and although it lacks a number of other analytical routines such as multiple regression, the methods available should be sufficient for most data analysis.

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Software	
Compuwriter word-processing package	£146
Trendspotter data-display package	£245
Basic editor	£20
Fortran	£40
Pilot	£30
Statistics pack in three volumes	£55
Other programs are available such as games and utilities and other business applications are due for release soon.	

Table 2.

Trendspotter is well-named. We found that the programs are robust and the displays excellent. Certainly a program like this is a great aid in the pictorial representation of time-based data. From the two example files used, some interesting trend information was gleaned which was far from apparent or even obvious from a close examination of the numerical data. It was unfortunate that the printer would not interact with this program to allow us to obtain a hard-copy listing of the data files. The manual refers to the use of plotters. In general, the documentation was very good and not difficult to read or use. Trendspotter is exceptionally good value for money at the quoted price.

The second application package supplied with the Compucolor II was a program called Comp-U-Writer. It is a word-processing package for the machine written by an U.S. company. To run the package, users are required to have the full 117-key keyboard. Supplied with Comp-U-Writer are about 20 key-tops. which replace most of those on the top row of the keyboard and provide dedicated functions within the package. Comp-U-Writer is supplied in the form of an A4 manual and two program diskettes — one of which is for security only.

When you load the program, the system requests a date entry and the screen is set into a 24-line blank page and a ruled heading for showing tabulator settings and messages. Comp-U-Writer can accept and hold up to 500 lines of typed text based on the Compucolor II 63-character-line format. This storage capacity is divided up into a number of 24-line pages.

The status line at the top of the screen shows the user on which line and which page the cursor is to be found. Comp-U-Writer accepts text entry directly from the keyboard and pre-formats the input on to the screen preventing truncation of words on wrap-around of the text from one line to the next.

Text is displayed as green characters on a black background in both upper- and lower-case. Once some text is entered, the user may move the cursor around the screen and any further text entered at the cursor position is automatically inserted into the line.

The cursor is a solid colour square and does not act as a background character. As it is moved along a line, the characters and line move one space to the right of the cursor which visually produces a most unusual effect. Each page automatically scrolls upwards, line by line, as more text is added and the page indicator is incremented. Four of the function keys

(continued on next page)

(continued from previous page)
allow the operator to jump around a document as follows:

- Beg — Place the cursor at the beginning of the document. (page 14).
- End — place the cursor at the end of the document.
- Next — move the cursor on to the next page of text.
- Prev — move the cursor on to the previous page of text.

A tabulator key is provided and there are two fixed — function keys offering set-tabulator and clear-tabulator options. Tabulators are indicated by markers on the status line at the top of the screen. Editing keys are provided to give the following functions: delete character, delete word, delete line and undelete.

The undelete key will restore text which has just been deleted inadvertently. Insertion occurs automatically if text precedes the current cursor position on a line or extra lines can be inserted with carriage returns.

There is the facility to mark blocks of text with a mark-beginning and mark-end function. The cursor is positioned at the start of the text to be marked and "mark beg" is selected which places a special red character at that point on the screen.

Cursor movement to the end of the text to be marked is followed by the "mark-end" key and the interposing information is displayed in red. Once a block of text has been highlighted in this way a number of facilities are available to manipulate the block using more fixed function keys. These are:

- Move block — if the cursor is moved to another part of the screen and move block actioned, the block is inserted at this position and the remaining space closed up.
- Copy block — produces a copy of the marked text at the current cursor position.
- Delete block — removes the marked text from the screen and closes up the display.
- Marked text may be unmarked by deleting the marking characters displayed at the beginning and end of the block. Screen editing is carried out as quickly as we have seen in other microcomputer-based word-processing systems.

Words or phrases may be sought and replaced through three function keys offering define, search and replace. The define key prompts the operator to enter the required word or phrase. Once completed, this is stored for future reference until changed by the entry of something else.

Depression of the search key causes Comp-U-Writer to search through the text held in memory and to place the cursor on any first match it can find. For several occurrences of the same word or phrase, the search may be re-enacted from the new start point. If replace is selected, the operator is prompted for input of text which is to replace any occurrence of the search option.

The replace option will alter every occurrence of the search string if desired.

Cursor movement may be either slow of high-speed. Text may be further formatted on input by selecting either the indent or centre functions. Centre causes any text entered to be positioned in the middle of the page. As more words are entered, Comp-U-Writer re-justifies the line to re-position it around the centre of the screen line until a carriage return is entered, forcing the cursor down on to a new line. The indent causes the current line of text to be started at a left-margin position which corresponds to a default value set by the user as part of another Comp-U-Writer.

The balance of the dedicated function keys and their facilities within Comp-U-Writer are associated with the disc file handling routines and the setting of options for producing hard-copy print-outs of the text.

Text may be saved and re-loaded from floppy disc through the save and load function keys. When you select the save option, you are prompted for the file name under which the file is to be stored. Comp-U-Writer then concatenates the current system data which was entered on loading the software program — or to the end of the file name and proceeds to store the information on the diskette mounted.

To load a file into Comp-U-Writer, the load option is keyed and a display is produced of the first five directory entries on the disc. Each entry shows the file name, the date of creation and the number of pages contained. Placed beside each file name is an individually-coloured square.

To load the chosen file, the user hits the colour key corresponding to that file. If the required file is not shown in the current display, the next five may be brought on to the screen by hitting the list function key.

Disc functions comprising; initialisation formatting of a new disc — file deletion, and renaming of files are offered through a similar colour-coded menu option selected by depressing the out key.

Printer options are provided for through two functions. The print key will allow for the setting of the following defaults — again through a colour-coded menu: Lines per page — page length; characters per line — page width; left-margin position; M indentation start point; baud rate setting — for printer: and start-page number.

Printing is started by selecting the print function as a command key and the operator is led through two screen menus offering the following option before printing starts:

Double spacing	Continuous forms
Two columns per page	Justified right margin
Marked text only	Auto page numbering
ETX-ACK protocol	Commence printing

While printing is in progress, the user may abort the function by pressing the escape key. The ETX-ACK protocol is a handshake procedure required by some printer devices. Marked-text-only is a very useful option which allows the operator to print blocks of text highlighted with the mark-beginning and mark-end key options.

The two-column selection forces Comp-U-Writer to print the text in two discrete columns on the page. This would presumably be used in a publishing-industry application.

We found Comp-U-Writer to be a very simple word-processing system but very easy to use by virtue of the colour-coded dedicated function keys. Dyad Developments offers the excellent NEC Spinwriter as the hard-copy printer for use with Compucolor II and Comp-U-Writer and many should find the package more than adequate for the preparation of non-standard letters and reports.

The only convenient way to erase the Comp-U-Writer memory of all text was to re-set the machine and re-enter the program at the opening sequence which meant having to re-key the system date. It was also a pity that the user is not given the opportunity to define which colour is to be used for the background screen or for the display the text characters on the screen.

We found that better character definition was obtained with white on black. Other than this, the package appeared to be robust and should prove to be useful for commercial users of the Compucolor II. Like Trendspotter, the program certainly offers very good value for money at £146.

Conclusions

- **For those interested in colour-display microcomputers, the Compucolor II must be a serious contender against systems using a colour television set as their output display device.**
- **The colours provided are not extensive, but rich and easy to select directly from the keyboard: the display quality is superior to TV output although some lower-case characters become ill-defined when buried in a screen full of text.**
- **The price of this machine is certainly competitive in the present U.K. market and the Compucolor II represents a good buy for those who would like a colour-based Teletype VDU for on-line working to mainframes.**
- **A ROM-resident screen editor would be a distinct advantage for the Compucolor II.**
- **The keyboard is of a high quality and should meet most users' requirements in terms of facilities ad features.**
- **The Basic interpreter has all of the commands commonly available in other machines and FCS is adequate although error messages from both are not well-defined.**
- **Trendspotter and Comp-U-Writer are both useful packages which represent good value for money: some of the more traditional commercial functions — payroll, stock, ledgers, etc. — are now needed before this machine becomes generally accepted in the business environment.**

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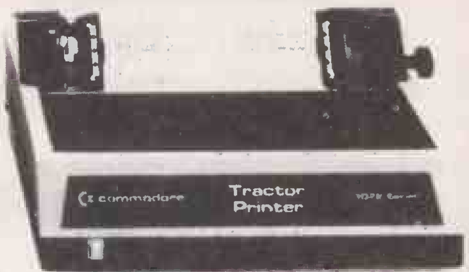

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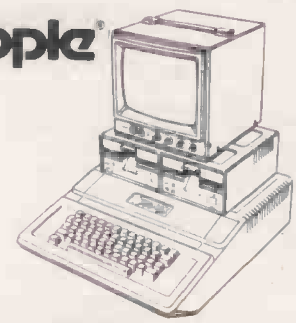

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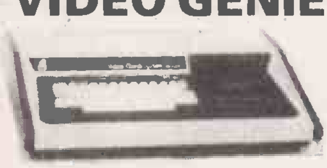

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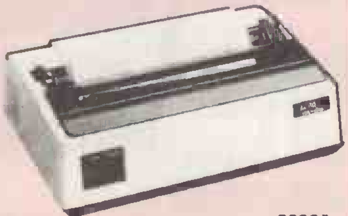

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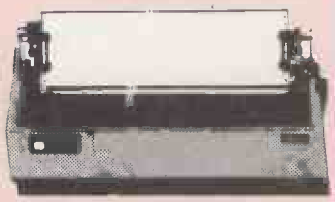

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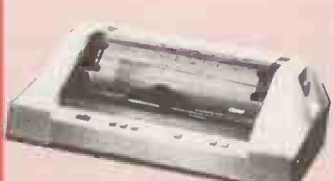

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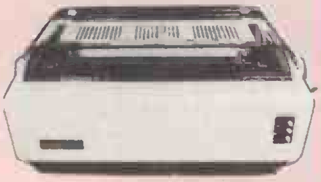

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• Circle No. 165

Prokit's machine-code routines ease data-entry problems

PROKIT 1 is a collection of machine-code subroutines intended to solve data-entry problems for programmers and operators alike. The program is available on tape, disc, and Computhink disc for 32K large-keyboard Pets with the new ROMs, and in identical format for the newer 8000 series SuperPets.

My version of Prokit was supplied by Intex Datalog of Eaglescliffe Industrial Estate, Stockton on Tees, Cleveland, a company which is a local Pet dealer and

by Joe Telford

which produces business software; Prokit is a spin-off from these packages and consists of a CBM disc and a manual.

The manual is of foolscap size, 20 pages in length and uses the front cover as an instant guide to the package. The manual is structured to take you through all the Prokit routines one by one and suggests ways to use Prokit in your programs. Prokit's use with tape, CBM disc and Computhink disc is covered in a section at the end.

The manual is essentially easy reading. In addition to the manual, there are a number of demonstration programs you can load to help you during a section on a particular routine. These programs are full of REM statements and easily understood.

The first program to load is Prokit itself. Once run, it settles in the top 3K of user memory, just below the visible screen. The operator must now set the top-of-memory pointers — unless that is done by any program containing Prokit. Examination of the top 3K of memory showed that no space was left to hold DOS support for CBM discs.

This plus the fact that all routines are called by the Sys command, with parameters ammended by Pokes, made me wonder why Prokit had been designed in this way while other programming-aid packages were patched into Basic.

Intex Datalog explains that the lack of DOS support was simply because during the run of the kind of large program you might design with Prokit, the operator would not need DOS support. Indeed, the Prokit package has to work for tape users and Computhink disc users, hence the version must be acceptable to all.

Intex Datalog's reason for not patching Prokit into Basic, via the Chargot memory area, is because there are a number of add-on programs and ROM chips using the patch, and even Computhink uses one. Prokit must be able to run with any of these loaded, in

any order — hence the apparently clumsy Sys/Poke technique.

The manual shows that there are six specific routines, each called by a Sys command, with parameters adjusted by one or more Poke commands.

They include:

1. Date input
2. General input of chosen valid characters.
3. Numeric inputs.
4. Screen-to-printer graphic conversion.
5. Search/match routine.
6. Screen-swap routines.

Once Prokit is settled into memory, the string Q$ is set to the null string and the

Size	3K memory not including extra screens
Type of program	Machine-code routines
Computer type	CBM 3000,4000,8000 series.
Market	Serious amateur/business programmer.
Cost	£35 plus VAT
Setting up	Q$ = "":. Poke 59468, 14 : Lower Memory
Routine calls	By Sys commands, adjusted by Poke commands
Special entries	Default entry allowed.
Facilities	1. Date entry. 2. General entry. 3. Numeric entry. 4. Graphic conversion 5. Search/match routine. 6. Screen exchanges.

Figure 2. Prokit package details.

Pet Poked into lower-case. Failure to set Q$ will cause syntax errors during use. Setting-up must be done in the Basic section of each program to use Prokit. The string Q$ temporarily holds the input after being formatted by Prokit. For this reason one normally copies the contents of Q$ into a more permanent variable, so that data is not overwritten by future input-routine calls.

The date-input routine allows input into Q$ of a date in the format dd.mm.yy. On calling SYS 29699, a reverse field bar eight spaces long is produced after the last print position. Only valid dates may be entered, e.g., 29.02.80 is treated as valid, though 29.02.81 is not, nor is 31.09.81.

If the reverse-field area is filled by a print statement, the cursor is returned to the start of the field before calling the routine. The reverse field will display a default value which will be accepted by pressing return. The return key can be pressed at any time during date input, but only valid dates will be accepted. When a valid date has been entered, the reverse field clears leaving the entry still on the screen but also in Q$ for processing.

If, during input, the operator presses the Shift-Clr key combination, the format dd.mm.yy. is superimposed on the reverse field as a memory jogger. A demonstration program "PKD" is included to show the use of the date-routine in a program.

A certain maximum number of particularly-chosen valid characters may be entered into the general-input routine. This routine is set up by creating a string VC$ containing all the valid characters allowed in entry and then by Poking the maximum number of characters into location 1. A call of SYS29696 produces a reverse-field bar, the length of which is governed by that Poke to location 1.

Only characters previously loaded into VC$ will be accepted and the Return key can be pressed at any point in the line. If the entry is less than the full bar length, Q$ will be padded with spaces to help future print formatting.

As before, default values can be set for Return key entry. Because they are in the entry field, the routine assumes they have all passed the entry-validation tests. All characters in the default entry are, therefore, accepted, valid or not. It is up to the programmer to ensure that the program default statements are valid.

This routine does not check for spelling mistakes — the size of a suitable dictionary makes it impossible. Again a program with many REMs is included for demonstration, and a more elaborate version is included as well as suggestions for applications such as telephone-number entry.

Numeric input

The numeric input routine allows the input and formatting of numbers, specifying the number of places before and after the decimal point as well as allowing positive-only numbers to be input or both + and - number entry. Before calling the routine, three locations must be Poked:

910: the number of points before the decimal point

911 : the number of points after the decimal point

912 : a 0 for only positive numbers or a 1 for both negatives and positives.

SYS 29702 calls the routine and the now-familiar reverse-field bar appears as in the other routines. Because numbers are entered from left to right, the number 12 in a four-digit entry field looks like 1200. When the decimal point is pressed, however, the routine re-formats the number to 12 automatically. An unwary operator can press Return at an inappropriate stage and obtain a garbage input a power of 10 higher than expected.

Two remedies are suggested in the documentation. The first alternative is to press the decimal point after your whole-number part has been entered, then the Return key. This is, in fact, what I suggest. The routine has a special extra key,], which behaves like the return key except that only numbers to the left of the cursor are accepted into Q$.

The normal Return key enters everything in the field into Q$. The demonstration program "PKN" shows ways of using the routine, reminding the operator that in accepting both positive and negative numbers, the '-' key can be pressed at any stage to make the number negative, and the '+' key reverses the process.

The previous three routines have an extra key which behaves as a Return key. The RVS key performs the same function as Return, but after it has been pressed, the location 32767 contains a 1 to indicate trouble. The suggestion given with the documentation and demonstrated by the accompanying programs is that an operator may notice an input mistake, such as a spelling error, possibly three inputs after it has occurred.

The operator can press RVS and a Basic routine can step the input back sequentially to the faulty line. This can be corrected and the correct inputs Returned to the position where the error was noticed. The program can then continue as normal.

The Pet, in some printer combinations, prints garbage on a printer when the screen is in upper- and lower-case. The graphics-conversion routine adjusts for that problem. As before, input from the screen goes straight to Q$. SYS 29711 adjusts Q$ to print correctly on a printer.

Search match

With the search/match routine, characters in string S2$ are searched for a substring S1$. Both strings must be set by the program, then SYS 29708 does the hard work. Location 32767 contains the number of the character in S2$ where a match starts. If the number 0 is found, no match occurs. The serious programmer will find that sequential searches using the routine are up to 200 times faster than using Basic.

An additonal benefit is the reduction of garbage collections when using the routine.

Figure 1. The Prokit memory map.

Address	Contents	Address	Contents
1	Length of field for general input routine.	29439	Top of spare screens 1K for each screen.
		29440	Start of Prokit
910	Number of spaces before decimal point/low byte of current screen start.	29696	Link to general input routine
911	Number of spaces after decimal point/high byte of current screen start.		
912	Sign for numerical input.	29699	Link to date input routine.
1025	Start of Basic program area.	29702	Link to numeric inputs
		29705	Link to screen exchange
		29708	Link to search routines
		29711	Link to graphic conversions
		32503, 32504, 32506, 32507	Directions for type of screen exchange.
		32767	Flag for search/RVS ROUTINES
		32768	Start of visible screen.

Its suggested uses are given in the manual and a demonstration is included. One which particularly interests me is the implementation of a Match statement in Basic, so that a Pilot-like language can be approximated.

In a Basic program, a number of data-entry forms may be duplicated on the screen. The suggested method is to create them in their entirety and call them to screen when needed by machine-code screen exchange. The routines allow the exchanging to be done, though not the creation of screen forms. This is done by a program called Screens which has 10 suggested input forms, which you may change to suit yourself using the editing facilities provided by the program.

The final results can be protected, the Screens program erased, and the operator's own business/administration program added. The complete combination can then be saved for future use. Once the screens are created, the next step is the use of the routine which calls the screens into view.

The control over screen exchange is as follows:

1. Memory copied to screen.
2. Screen copied to memory
3. Screen and memory swapped.

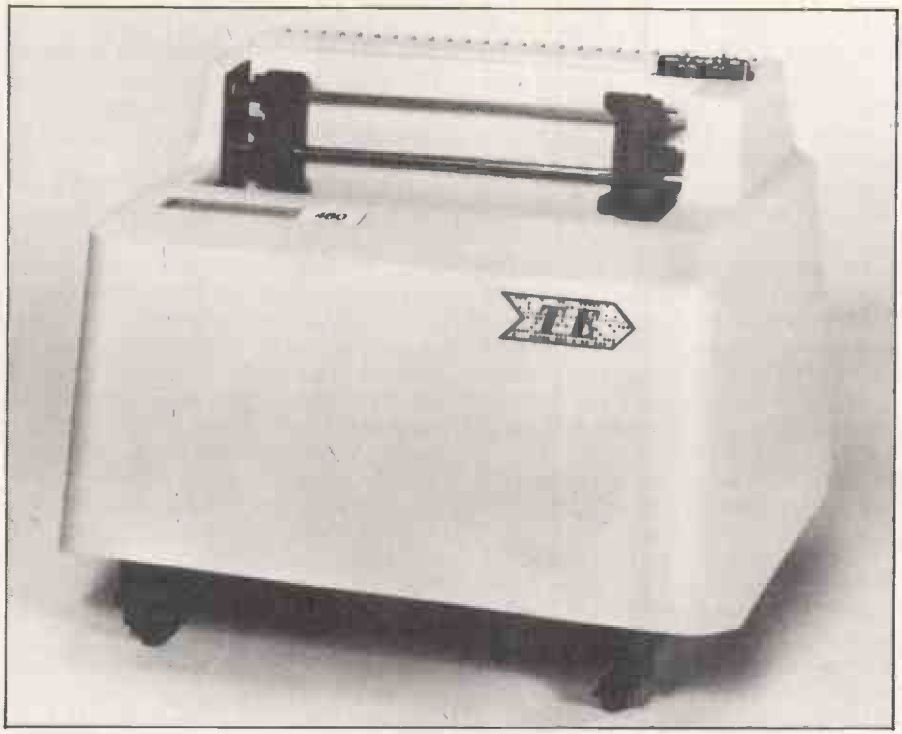
The type of exchange 1,2,3 is governed by Pokes to locations 32503,32504,32506, 32507 and called by SYS 29705. If more than one hidden screen has been created, additional Pokes to locations 910 and 911 are needed to select the particular screen.

Each screen of information uses up an extra 1,000 bytes below the Prokit routines, so one is advised to use the minimum number of screens necessary for any particular business program. The complete routines are demonstrated in a program 'TDEM', which is very impressive.

A section of the manual is devoted to an explanation of how to use Prokit in one's own programs, and deals with saving the entire memory on tape, CBM disc and Computhink disc. Commercial software writers wishing to use Prokit may contact the distributor to reach an agreement over copyright.

Conclusions

- **I tried especially hard to create a situation which affected any routine, and in all situations, as long as the correct Pokes, Sys and valid characters were set, Prokit behaved according to documentation.**
- **My biggest worry now is that any data errors in programs which I write will be caused by poor programming on my part, rather than their poor entry technique.**
- **It is worth looking after the manual as the Screens program and swapping routines are more difficult to remember than the other routines, most of which I have now committed to memory.**
- **All in all, a very useful package.**



The action of the Tiger

THE PAPER TIGER made its first appearance in the U.K. in September 1979 as an eye-catching design — one of the American contenders against the onslaught of the Japanese dot-matrix invasion. Like the majority of dot-matrix machines, that model, the 440, had a seven-wire head, producing a text crippled with truncated decenders which was legible, useful for listing and general computer donkey-work, but a poor second to the Qume/Diablo front when it came to word-processing.

Substantially the same machine is still available as the 445, but the manufacturer, Integral Data Systems, is closing on the heels of the expensive daisy-wheel designs with two new offerings, the 460 and the 560, each of which offers true descenders and a print appearance not far removed from that of a good typewriter.

The improvement is achieved by increasing the number of wires in the head to nine and by staggering them so that the individual dots to some extent blend into a smooth line. High print-speed is maintained at around 150 characters per second, and according to Integral Data Systems, the machine "also offers a bi-directional logic-seeking device to enhance its print optimisation characteristics".

Teleprinter Equipment, the U.K. distributors, lent us the 460, the version designed for standard 8.5in. tractor-feed stationery, although the adjustable tractors will take all the smaller roll sizes. The 560 is a similar machine mechanically, but with a maximum carriage width of 14.75in. and a newly-designed case. The 460 retains the upright moulded resin case of the earlier Paper Tiger model.

The industrial design of the machine was, frankly, a disappointment, as if the good ideas and the ingenuity had all been used up on the internal workings. The case in particular, a single resin moulding that slips over the chassis from above, is an ergonomic flop, and for most of our trials, we dispensed with it altogether, wedging a piece of rubber into the micro-switch which cuts out the mains when the chassis is exposed.

by Chris Bidmead

In everyday use, this cover probably works well enough. The poor design becomes evident only when trying to remove or replace it — to change the ribbon, for example.

The 460 and 560 each use the same ingenious ribbon cartridge — a kind of oblong plastic box into which the mechanism stuffs the ribbon at one end while pulling it out at the other in a continuous Möbius loop. Ribbon life is now claimed to be increased from six million to nine million characters compared to the previous open-ribbon system, although the new cassettes now cost £13 each as opposed to £9. This represents a small saving, until you prematurely damage a ribbon and have to throw it away, because there seems to be no easy way of repairing the loop.

The machine arrived with tell-tale inky finger marks on the cover, indicating that somebody had had trouble fitting the ribbon. We quickly discovered why — although the ribbon is neatly cartridged, its inked surface has to be handled to loop it round the four guide rollers. Replacing the case afterwards is not an enjoyable business. There are too many points at which the strangely-shaped case can foul the chassis.

The dedicated owner, who has bought the machine for its undoubted versatility — RS232 and parallel interfaces are options, and the electronics offers a choice of font sizes, as well as a proportional-spacing option — will no doubt become adept at handling the case, guiding it back so that its four slots engage simultaneously over the chassis bolts.

Even so, the day will arrive when he, or somebody, picks the machine up to carry it across the room. The case is held on to the chassis by four finger-tightened nuts — or, in transit across the room, *vice versa*. The ease with which the chassis could drop from the bottom of the case hardly bears thinking about.

On power-up, a toggle switch gives the option of self-test, continuously printing out the whole character set. The manual also recommends using this switch "momentarily" for emptying the buffer to abort printing. Your idea of "momentarily" had better correspond with the manufacturer's, because if this moment is prolonged until the printer begins to self-test and the print-head is not in the home position, the self-test logic insists on printing out a full line, remorselessly jamming the print-head against the right-hand limit of travel with an awful grauching noise.

When this happened, we dived for the mains-off switch, but not before we had fouled the ribbon and blown the print-head motor fuse. To replace the fuse and the ribbon we had to remove the cover.

The 460 appears to offer a choice of four character fonts, though in reality they are all a re-dimensioning of the same basic set. Thus the smallest, 16.5 to the inch, resembles book type, particularly when printed out proportionally; and the largest is the familiar dot-matrix 'Expanded'. The appearance on the page is close to a good cloth-ribbon typewriter, the slight unevenness giving the text a hand-wrought look.

Occasionally, particularly at the beginning of lines, a character appeared to be squashed sideways, and this might create problems of legibility, especially with figures printed in the smallest size. Apart from this, and a raggedness of the left-hand margin which we managed to cure by tightening the drive belt, the printed output is very elegant. The smallest type size enabled perfectly-legible full assembler listings to be made on 80-column paper.

The 460 on trial was supplied with the full graphics option, which includes a 2K buffer and the capability of addressing each needle individually, so that in theory, the printer will print any pattern for which you have the patience to write the software. If you do not have patience, but have an Apple, a commercial package called Apple Graphics Dump will send screen graphics directly to the Paper Tiger.

We tested the graphics to the extent of printing a series of chequers of various sizes, and everything worked very well and at high speed. Resolution is excellent, comparable with so-called infinite-matrix printers.

We drove the printer at its top speed of 9,600 baud and ran into buffer overflow problems, as our standard printer-driver software is based on ETX/ACK buffer control, and so failed to recognise the DC1/DC3 protocol observed by the Paper Tiger — see table 1. All the other printers we have tested offer both protocols, either simultaneously or as "strappable" options, and we had to spend some time with a hot soldering iron around the sensitive parts of our Bitstreamer II I/O board before solving the problem by implementing the Data Control Ready handshaking line of the RS232 interface.

Although we used the printer only in its RS232 mode, the machine can be re-configured as a parallel Centronics-type printer with some nimble-fingered re-strapping. This is not something one would want to do every day, but the inaccessibility of the relevant jumper board is one more manifestation of the inward-looking design, which seems to tolerate but not welcome human contact.

Another example, common among printer manufacturers, is the misuse of miniature DIL switches. These devices, though robust, are intended on the whole for once-and-for-all setting of options — so that defining the baud rate and parity is a legitimate application.

The Paper Tiger leans on them too heavily for setting and re-setting such variables as auto-line feed, proportional spacing, form length and character density. True, these options can also be adjusted through software, and in a properly-integrated system probably would be. However, by the time you have re-written your operating system, the domestic laser printer will have arrived.

Limited word-processing facilities are built into the machine, so that it is possible to write software to alter margins and execute absolute tabbing both vertically and horizontally. In particular, the right-justification mode offers very clever word-wrap facilities.

Text is sent to the printer without carriage returns — except at the end of paragraphs — and is automatically broken at the correct spaces into lines that are then padded out to be of identical length. There is no easy way, though, of producing underlines and centring text.

Conclusions

- **The Paper Tiger is a fast dot-matrix printer with correspondence-quality resolution.**
- **The machine should be trouble-free and inexpensive to run — but the ribbons are only available from the distributor.**
- **A good variety of setting-up options means the printer should be able to match virtually any system.**
- **Poor industrial design mars an otherwise well-conceived machine.**
- **At £795 for the 460, £995 for the 560, the new Paper Tiger is not exactly given away. With Japanese competition hard on its heels, these prices may well fall soon.**

Table 1

Speed test comparisons with daisywheel printers are not really relevant because the applications are different, but we ran two of our standard speed tests on the Paper Tiger to see what kind of speed advantage a good dot-matrix machine could give.

Test	Time taken	Comments
Standard-text test	1'03"	57 cps — half the claimed best speed. Yet the manufacturer does not define the conditions of its own test. The machine was in justify and proportional mode, so had a good deal of thinking to do. Under these conditions it was not much faster than a daisywheel printer.
Formatted-text test	0'26"	Twice the speed of a good daisywheel printer. The print-head moves very fast, bi-directionally converting strings of spaces into absolute tabulations. Yet direct comparison with daisywheel speeds is unfair — the Paper Tiger did not provide underlining in this test.

Spinwriter's quality is not just on paper

OUR FIRST impression on unpacking the NEC Spinwriter was one of superb production engineering. The case is the apparently now industry-standard cream colour well-cast in three metal parts which fit together perfectly. The front cover is articulated on long hinges which lift it clear of the tractor feed when fitted and it snaps shut again with reassuring firmness. Even the disposable security bolts which hold the machine during shipping are beautifully tooled.

Not one but two main power switches are provided at the front and rear, ingeniously linked so that the functioning switch is defined as whichever the user switches on first — you do not have to fumble for both of them.

The purpose of this is not entirely clear; perhaps the rear switch is intended for applications where an unqualified user might switch off the machine accidentally.

Optionally, the machine will self-test on power-up, though only in the most rudimentary way by reiterating the familiar holo-alphabetic sentence about the fox and the lazy dog. The built-in diagnostics also appear elementary at first sight. They are based on combinations of

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a single light and an alarm bell; so that, for example, the light and the bell with printing continuing indicates "Paper out", light and bell with printing arrested means "Cover open", while a repeating bell broadcasts the news that all is not well with the print-head. Until one masters these various cries for help, the teething period can be very noisy, but with practice, it becomes easy to identify the fault quickly.

An obtrusive feature at the back of the machine is a chrome-plated wire cage responsible for monitoring the even feed of continuous stationery to the platen. The equivalent on other machines is a simple grill which ensures that incoming paper does not choke the air intake. The Spinwriter device is hinged, and requires continuous paper to be threaded through it so that a microswitch can detect the paper-out condition.

It adds to the complication of loading continous stationery and means that if using single sheets, something has to be done to override the switch. Though the arrangement works well, we were left with the feeling of a certain amount of "chrome-wire overkill" in this department.

Access to the internal workings is a simple matter of operating two levers inside the cover, which lifts off cleanly with no trailing wires. The interior is uncluttered and well laid out, with most of the components easily accessible. None of these, incidentally, seems to run at much more than blood heat, even after sustained operation.

The electronics occupies four large, well-mounted boards at the rear, three of which run almost the whole width of the machine. From the size on the boards and the mixture of components, it becomes clear that the very latest technology has not been used, but this seems to be a deliberate design choice — part of the overall conservative philosophy.

One element of the design is obviously innovatory — the tulip-shaped print-element, or "thimble". Unlike the Diablo daisywheel, but like more recent wheels such as the Ricoh, each petal carries a pair of characters.

This introduces the need for a vertical shift, with corresponding complications to the print-head design, but the trade-off is a gain in print speed and the ability to offer a total character set of 128 characters compared to the more usual 98. Changing the thimble seemed to be marginally more difficult than the corresponding operation on the Diablo, though this may have been due to our lack of familiarity. On both machines, the ribbon has to be removed first.

Annoyingly, the left edge of single sheet paper sometimes caught the print-head, causing the ribbon to ride up out of position, and the lid had to be lifted to adjust it before printing. We have encountered a similar bug on other machines: there is often a position of the paper guides that causes the paper to foul against the print-head in its zero position.

Test	Time Taken	Comments
Standard-text test	1'31"	43 cps — rather less than claimed. The manufacturer does not, however, define the conditions of its own test.
Formatted-text test	0'57"	About the same as a medium-speed printer.
Graphics test	7'40"	Not impressive.
Tabbing test	0'43"	Very good. The Spinwriter seems to handle tabbing cleverly.

• Formatted-text test. The 8080 CPU loses a relatively large amount of time in calculating print-head movement, so that the speed of printing heavily formatted text is disproportionately slow.
• Tabbing test. The Spinwriter seems to translate a string of spaces into a single continuous carriage movement, resulting in print action which is smoother than the usual judder associated with the LPrint Tab instruction from Basic on ordinary daisy-type printers. The trick with the latter is to translate all Tab instructions into absolute tabulator instructions, using ESC LT «ascii character». This also works on the Spinwriter and results in an improvement in tabbing speed.
• Graphics test. The Spinwriter makes the necessary calculations so slowly that in this mode it runs some 50 percent slower than its nominal print speed would suggest. The machine also seemed to be somewhat careless about its print-impression control when running in graphics mode: its full stops almost drilled through the paper.

Table 2.

Mechanical single-sheet feeders are sometimes programmed to move the print-head to the centre during paper-change, and it seems a pity that this cannot be arranged to occur during manual paper-change. The remedy is to be careful on setting the paper guides

On one occasion, the ribbon broke — our only carbon ribbon — which gave us the chance to discover that the ribbon cases are so well engineered that it is a simple matter to ease them open, effect the repair, and snap them shut again. In fact, they are so well made they are virtually refillable,.

Which they might well need to be. None of the computer-consumable suppliers we talked to knew of any alternative manufacturer of Spinwriter-compatible ribbons and thimbles. There seems to be little difficulty in obtaining supplies from NEC — at least not in London. Yet the absence of "second-sourcing" is something would-be buyers certainly ought to take into account.

The model under test was the 1515, chosen as the version which understands the Diablo escape codes of our word-processing software. Physically-identical machines are available to match a variety of interfaces, notably Centronics, parallel Qume, and Current Loop. The Diablo version seems to correspond closely to the older Diablo escape codes, which are a sub-set of the current protocol used on the Diablo 630 but the Spinwriter does not understand any of the later updates like Remote Re-set and Top Margin. The 1515 is, in fact, described in the Spinwriter maintenance manual as a direct replacement for the Diablo 1610 a machine now two generations old.

Its chip technology seems to belong to much the same era, and it is clear that assessed alongside newer machines like the Diablo 630, the NEC Spinwriter is a little long in the tooth. Apart from the novel tulip-shaped print-element which may well owe its existence as much to the laws of patent as to design progress, and a major re-think of the printer chassis "borrowed" back by Diablo in its new range, the Japanese device appears to be little more than a collation of beautifully-engineered refinements on the old Diablo 1610/20 range.

The result is a conservatively-styled, beautifully-built printing terminal with a reputation for sustained trouble-free performance. Its philosophy seems to be to accept a slight trade-off of print quality against increased print speed, although this gain is unfortunately lost whenever the somewhat senior 8080 CPU is called on to deliberate on print-head movement optimisation — see table 2.

Within these limitations , the Spinwriter is quiet, fast, and gives the impression of being very assured in operation. Memec, the U.K. distributor to which we are grateful for the loan of the review machine, recommends an end-user price of £1,950, which is not exactly a bargain. Shop around and be prepared to argue: these prices are not carved in stone. Be careful, though, to make sure that the dealer from which you buy can give you support at the price you choose.

Conclusions

- **Mechanically fast, the spinwriter still "thinks" slowly.**
- **There is no second-source yet for Spinwriter ribbons and thimbles.**
- **The print quality, though very good,is not of the first order.**
- **Manufacturing quality is superb.**
- **The Spinwriter is a mature product in the very best sense: bug-free, increasingly well-supported, and as reliable as the best machines available.**

Writing your own business software

PERHAPS the best piece of advice in this series will be given in the first sentence — don't. Producing good business software is a job for a software house. Its staff will, ideally, be able to take the time and trouble required, knowing that their investment can be recouped from volume sales of a successful package. Their experience will produce results of a standard you will find hard to match.

If you are still reading this, you probably fall into one of the following categories:

- You have a specialised problem, cannot find a package, and custom-written software would cost you the earth.
- You have plenty of time and are convinced that you can do the work yourself.
- The sales literature for your machine says that programming can be learnt by anyone with a few hours to spare.

The way to avoid the hours of work normally involved in designing, programming and testing your system is to have someone else do most of it for you. Since about 80 percent of all programming is not concerned with the application in question, but relates to input validation, data conversion and other standard routines already in existence, it follows that 80 percent of any typical program has already been written.

This series aims to provide you with the 80 percent and help you write the other 20 percent. I shall assume that you already

by Charles Somerville

have some programming experience, and, as Basic is probably the most commonly-used language, it will be used in all the examples.

All the routines are already incorporated in successful commercial packages, using Microsoft Basic and CP/M. Users of other Basics, and perhaps other languages, should be able to convert the routines easily for their own use.

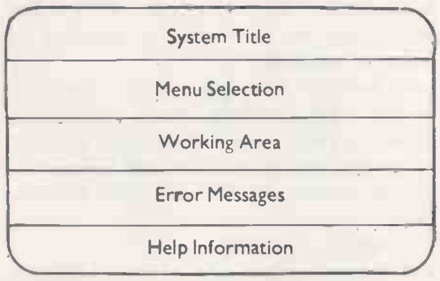
Imagine that you are watching ITN's *News at Ten*. The newsreader's head appears at the top left-hand side of your television screen. As the program progresses, more of him appears, until you can see a head and shoulders lining the left-hand side of the screen.

At this point, the newsreader's toupe begins to disappear from the top of the screen, while his torso climbs on from the bottom. By 10.30pm you are left with a view of a pair of shoes, three inches of sock and some turn-up.

That would not be the standard of presentation you expect on your television, so why should the average computer user have to tolerate information appearing and disappearing on a VDU in the same manner?

Good screen presentation is an essential part of good software. Not only does it make a system easier to use, it can make it easier to sell, too.

One of the most important aspects of any software you may write is a standard screen lay-out.



Distinct areas of the screen are reserved for the following purposes:

- System title: Displaying the title of the system is use is especially helpful if several people will use the computer in the course of a day's work.
- Menu selection: The method of programming which this series describes as based on a menu system of selecting processing options. Showing the chosen option is a reminder to the user.
- Working area: This is where your 20 percent fits in. The working area will be used to display application-related data, and to accept information from the user.
- Error messages: All error messages will appear in this area. They will be highlighted in some way to catch the user's eye.
- Help area: This area will be used to display additional guidance to a user who cannot follow instructions given in the working area.

The number of lines allocated to each area depends on the display format of the machine you are using. For the 'standard' 24-by-80 screen used in examples, the screen is divided as follows:

Lines 1 and 2:	System title underlined.
Line 3:	Blank
Line 4:	Menu selection
Line 5:	Blank.
Lines 6 - 21:	Working area.
Line 22:	Error messages
Lines 23 and 24:	Help information

The idea that information should not be allowed to roll-off the screen does not mean that the screen should be cluttered with redundant information. Once a portion of the display is no longer helpful or relevant, it should be erased.

For instance, the user may be presented with a list of 10 choices, followed by the instruction to choose one of them. Once the choice has been made, only the chosen item should be kept on the screen. The rest of the list, and the installation, must be erased.

If we are to use the computer as outlined, the following facilities must be available:

- A method of clearing the whole screen.
- A method of clearing a portion of the screen.
- A method of highlighting certain areas of the screen, e.g., intensified or flashing characters or reverse video.
- A method of positioning the cursor at a certain point on the screen.

The Superbrain and others use Hexadecimal "DC" ASCII form feed to clear the screen, but Vector Graphic uses hexadecimal "04". The information for your machine is probably tucked away in an appendix to the user manual.

Clear screen

Having discovered, say, that the clear-screen character for your machine is Hexadecimal "0C", you could use the statement PRINT CHR$ (12)
to clear the screen. To anyone else reading the program though, this could mean cursor left or clear to the end of line if they are used to a different machine. A better idea is to have an initialisation subroutine in your program:

```
30000 REM INITIALISATION SUBROUTINE
30010 CLS$ = CHR$ (12) : REM CLEAR SCREEN CHARACTER
30999 RETURN
```

You can then use CLS$ to clear the screen throught the program. Perhaps the best idea of all is to keep the value on disc, and enter it as part of the initialisation subroutine. This means that your program can be transferred between different makes of machine by updating a "configuration" file. The subroutine might look like this:

```
30000 REM          INITIALISATION
                   SUBROUTINE
30010 OPEN         "I", 1, "CONFIG"
30020 INPUT #1,    CLS$,CLE$,CLL$,
                   HION$,HIOFF$,X,Y,
                   FIRST$, LEADING$
30030 CLOSE # 1
30999 RETURN
```

Note that besides the value of CLS$, we have read in several other variables. CLE$ and CLL$ are the characters to clear to the end of the screen or to the end of the current line, respectively. HION$ and HIOFF$ are used to control the highlighting of error messages.

They switch on and off any flashing characters, highlighting characters or reverse video. Should your VDU have none of these features, set HION$ and HIOFF$ = "" when creating the configuration files, and they will have no effect when used. The other four variables are used in positioning the cursor. A typical computer will position the cursor

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by writing a string of characters to the screen in the form:

Cursor lead-in sequence + column number + row number.

The cursor lead-in sequence will be one or more characters which tell the video-driver software/firmware that a cursor positioning operation is required. Once again, lack of agreement between manufacturers means that a Superbrain uses Hexadecimal "1B59" ASCII Escape Y while a Vector Graphics uses Hexadecimal "1B". The same applied to the column and row numbers.

Many manufacturers add a fixed number to the row and column numbers to allow them to be represented by printed characters. Hence to position the cursor to column 30, row 12 on a Superbrain:

```
CURSOR$ = CHR$ (27) + "Y" + CHR$
(32 + 30) + CHR$(32 + 12)
PRINT CURSOR$ ;
```

You will see that this machine adds decimal 32 to both the row and column numbers, and requires the column number to be stated before the row number — unlike our general-purpose examples.

All these differences between machines can be overcome by defining a Basic function to generate cursor-positioning strings. This would be included in the initialisation routine as follows:

```
30040 IF FIRST$ = "X"
  THEN DEF FNTAB$(C,R)= LEADIN$
  + CHR$ (X + C) + CHR$ (Y + R)
  ELSE DEF FNTAB$(C,R,) = LEADING$
  + CHR$(Y + R) + CHR$(X + C)
```

FIRST$ will have been set to "X" on the configuration files if the machine in question expects the column X co-ordinate to be given first. Otherwise FIRST$ will have been set to "Y". X and Y are the decimal values which have to be added to the column and row numbers respectively. We now have a function which can be used on any machine in either of two ways.

Commonly-used cursor positions should justify creating some cursor positioning strings as part of the initialisation routine:

```
30050 CUR 3012$ = FNTAB$ (30,12)
```

would initialise the variable CUR3012$ so that:

```
PRINT CUR3012$;
```

will always position the cursor at column 30, row 12. At other times, the variable CURSOR$ could be set to the required value by use of function FNTAB$ just before it is needed.

You may be wondering why the cursor is positioned with:

```
PRINT CURSOR$ ;
```

and not just:

```
PRINT CURSOR$
```

This is because, unless you include the semicolon, Basic appends a CR/LF — carriage return and line-feed — sequence to your character string, causing the cursor to jump to the start of the next, ruining your cursor positioning.

Microsoft Basic has a command, **WIDTH 255**, which suppresses the insertion of CR/LF, but as this is not found in most other Basics, it will not be used here.

Next month's article will deal with data input and validation and acting on the result. In the meantime, try the following:

- Find the screen-control characters for your machine.
- Create a configuration file. Set all the nine variables to the correct values, open a new sequential output file, and write a single record consisting of the variables. For example:

```
1000 CLS$ = CHR$(4) : CLE$ = CHR$
(15) : CLL$ = CHR$ (16)
1010 HION$ = CHR$ (26) : HIOFF$ =
CHR$ (26)
1020 X = 127 : Y = 127 : LEADIN$ =
CHR$ (27) : FIRST$ = "X"
1030 OPEN "0", 1. "CONFIG"
1040 WRITE #1, CLS$,CLE$,CLL$,
HION$,HIOFF$,X,Y, FIRST$,LEADIN$,
1050 CLOSE #1
1060 RESET
1070 END
```

- Write a program which uses an initialisation routine to read the configuration file. Clear the screen. Write a highlighted message to the error-message area. Write "TESTING" to column 36 onwards of the menu-selection area. Clear the error message line. Write information on the first four lines of the working area then erase from the second line of the working area to the end of the screen.

No holiday for seaside resort's hard-working Apple

ANYONE WHO ventures towards the East Coast from, say, the bustle of London's Old Street Station could be forgiven for thinking that time was playing tricks — that Freddie Laker had never put America within the range of most people's holiday budgets, that the glossy sunday supplements of most had never brought exotica, squalor and glamour from far-flung corners of the earth into your sitting room, and, in fact, that the late sixties, and early seventies, had never really happened at all.

The Essex coastal villages typically have the air of beleaguered settlements whose inhabitants chose to bypass the stark facts of London life by building a closed world of net curtains, chicken in the basket and holiday camps.

It also has a remarkably flat landscape, which some might find rather on the depressing side. The land beyond the pretty little village of St Osyth is flat. Towards the sea, it is punctuated by rows of small beach huts; at the beach itself there are more than 2,500 holiday letting units. At the height of the season, the place reverberates with the sound of bingo callers, fruit machines and kids.

We went there out of season though, when it is a ghost town of empty chalets and abandoned plastic buckets. Our destination was the Seawick Holiday Lido, largest holiday homes complex at St Osyth Beach and from Whitsun to late September the destination for thousands of visitors — mainly east Londoners bound for one of the 150 chalets or 600 holiday caravans.

Seawick provides more than just accommodation by the sea, though. In fact, the management is quietly proud of the fact that once a holidaymaker has arrived, there is no reason why the family should leave Seawick.

Star performers

For example, Seawick's tenants have the Club El Tora Leisure Complex, two bars, heated swimming pool, restaurant, dance floors and a medieval banqueting hall complete with hogs' heads and shields. There is bingo, a children's playground, an amusement arcade, a shopping centre, and the Seagull pub — where every night in the season you will find Jolly Roger, "the virtuoso of the organ". There is a big-name entertainment programme, too, offering among other attractions Acker Bilk, Marty Wilde, Gary Glitter and Joe Brown and the Bruvvers.

There are "space invaders" games in the amusement arcade, but you feel that not much else has changed at Seawick in the past 20 years — that is, until you visit the nerve centre of this substantial business operation. In the office of Seawick's accountant John Lambert, you will find his Apple II microcomputer.

The Seawick Holiday Lido was established just at the end of the Second World War and now covers some 50 acres of land. John Lambert explains that it presents immensely-varied administrative problems: "'Here we sell everything from

by Cathy Lane

a tiny box of matches to a £5,000 caravan — a big range of items at widely-varying prices and in very different volumes. Our turnover is in excess of a million, but, of course, that money is earned in a very short space of the year.

"Every June and July we're suddenly and completely overwhelmed with money, mostly cash, and I'll be spending virtually every morning counting wads of grubby pound notes".

Seawick's staffing levels also vary enormously from about 120 people at the height of the season, including part-time bar staff and chalet cleaners, to a core of just 30 or so for the rest of the year.

What is more, all the money may be taken in the summer, but winter is the busiest time of the year for John Lambert. That is when the sums have to be done and all the prices set for the following season. The bills have to be paid for the 25 or so suppliers; contracts for the caravan owners are renewed; and the Lido must ensure that it remains ahead of its competitors, checking facilities and potential new offerings and the performance of others in the same business.

To help him monitor outgoings, Lambert had been using a bureau in Ipswich for the purchase ledger and some analysis. This certainly helped, but by 1978 it was becoming unsatisfactory: "The bureau's prices were constantly rising and by the end we were paying as much as £150 a month. Combined with the time it took to send data to the bureau and eventually receive the reports and the books back, that system was just not good enough".

Like any sensible accountant in the last two or three years, Lambert had been taking an interest in the development of the small-computer market. He gradually became convinced that Seawick both needed and could afford a system of its own.

His only previous computer experience was with a large IBM machine at, his previous job but his young colleague, Steve Gay, had studied computing as a recreational subject at school for a year. So between them, they had some appreciation of the potential for computers.

They had scant knowledge of programming though. That did not stop them being convinced that they needed a system which they could program themselves. That was largely due to the special problems of running Seawick. Their encounters with computing had already led them to the conclusion that no off-the-shelf package would match their requirements well enough: "We're just not a standard kind of business". Also they felt that no brought-in programmer could do a better job of understanding the Seawick operation than they would.

Steve Gay and John Lambert attended a one-day conference-cum-demonstration held by Tandy and were duly impressed. The impact was dissipated, however, when a TRS-80 was demonstrated at Seawick: "For a start, the chap didn't seem to know as much as we did. It was a disaster". This was a disappointment for by this time they had bought the Tandy reference manuals and started to learn programming.

Help from dealer

They had some help from Lambert's brother-in-law, a lecturer in computing at Southampton Polytechnic, and between them they had already worked out how a purchase ledger could be devised for Seawick.

Then in September, a microcomputer dealer called Micro Management opened a shop in nearby Frinton. Lambert found he was talking to people who seemed friendly, helpful, and, above all, easy to talk to. After several visits to Frinton, they elected to buy from Micro Management an Apple II with two floppy disc drives and a matrix printer. On top of this they tested, liked, and bought Micro Management's own off-the-shelf purchase-ledger program on the understanding that they would receive assistance with writing subsequent programs. The total cost was in the order of £2,500.

From the outset, the computer was very much an accounting machine. Most of the other people at Seawick were dubious of its value, but Lambert and Gay had to be committed — for one thing they had no option but to start work on it immediately. They had already stopped dealing

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with the bureau and a large backlog of work had built up.

The main problems at the outset were due to their lack of understanding about how the computer worked. That was compounded by the seemingly-inevitable program faults. "The hardware has always been very reliable; it's us who have proved unreliable".

The purchase-ledger software had to be modified quite substantially; Seawick has nearly 25 suppliers, but needed 1,000 cost-analysis codes. The program allowed only for 100.

Batch processing

Even after Micro Management had adjusted the program, it continued to give problems — the kind of problems that Lambert and Gay could not solve without understanding the computer. Lambert now believes that "it is essential to be able to see what goes on in the computer — you need to see how data are being stored on the discs".

He also had to devise his own operating methods for the system, and one important result of the exercise is that he has effectively adopted those usually more characteristic of large companies: "For instance, when we first went to Micro Management, we were told that you just have to key in your invoices every day or each week or so and leave them. Yet it's not that simple, because you do have to tally all your figures back. So now we always batch-list everything in a control book before feeding it into the computer".

Despite the hiccups, the purchase ledger was sorted out in two months and Lambert is grateful for the help they received from Micro Management. By then, they had already started on a sales-ledger program — helped interestingly enough by piles of brochures from all types of micro suppliers: "Between them they almost told us how to write the program."

The sales ledger has a file of 500 or so caravan owners who pay ground rent to Seawick, as well as electricity and repair bills. There is evident relief in Lambert's voice at the prospect of computerising this: "At last, we're getting rid of that laborious Kalamazoo system. It may have been all right in its way, and it would certainly be fine for most businesses — but we're unusual. The caravan rents account for about only one-fifth of our total revenue, but they were very complicated to calculate. We're sending out computer-generated statements now, which really do make people better payers, and soon we'll be sending out contract-renewal forms and the invoices automatically".

Once the sales and purchase ledger were completed, Lambert found himself with many other things he wanted to do at once; a nominal ledger, a cigarette stock-control program, some method for handling bar inventory.

Lambert is pleased enough with the ways things have gone, though: "I was extremely happy that the purchase, sales and nominal ledger were all set up in time to cope with 1980 — good going I think. Whether we could have done it without Micro Management's help is debatable.

"We also have the cigarette program running very much as a test-bed for other stock control. Actually," he confides, "I hate cigarettes. I don't smoke, there's no profit in them and there's so much at risk. Yet we must stock them; and it's just because there isn't much profit that it is essential to keep a close eye on them". This program involves one file of brands and another for the outlets round the Lido, so that the incoming and outgoing stocks can be checked.

Payroll

John Lambert intends to consolidate the work already done on the machine: "We've had to adapt our working methods to suit the computer: I'll change that. We have thought about doing payroll on it — at the moment we still use the Kalamazoo system. I don't think it would be beyond us to write our own program, though whether we could do it for the same price as buying a commercial package is another question".

Exploration and exploitation of new worlds are the goals of Bob Merry's two-part game *Star System*.

STAR SYSTEM

STAR SYSTEM is a game of exploration where the program will create a planetary system for you to explore and exploit. Some of the planets may be inhabited and you will have the chance to contact them and, if you are lucky, establish friendly relations which can lead to the exchange of gifts.

In designing the game, I have given the option of stopping it at any point and recording the position so that the game can be played using new data or data saved from a previous game. Because of the complexity of the game, the playing part fully occupies 8K and the instructions and preparation are put into a separate program.

This first program creates a Star System, consisting of several planets each with its own environment, which is determined by a mixture of luck and logic, e.g., while the atmosphere of a planet is randomly selected, the temperature is determined by its orbital position relative to the star and the other planets. Once the system is created, it is recorded as a data tape, which is saved for use in the game program.

Because of this and the use of machine code for part of the display, it would be difficult to implement the program on systems other than the Pet for which it is intended — I would be very interested to hear of anyone who does manage to translate the ideas contained in the game on to other systems. The program listings given are written for the old ROMs, but since I have both sets of ROMs available thanks to a Basic Switch, I have developed

Table 1. Machine-code section of program.

033A	A9 00	LDAIM	00	;Stores address 32768
033C	85 01	STAZ	01	;in zero-page locations
033E	A9 80	LDAIM	80	;01 and 02
0340	85 02	STAZ	02	;
0342	A9 48	LDAIM	48	;Loads 72 into the
0344	8D F9 03	STA	03F9	;COUNT 1 location (1017)
0347	A9 04	LDAIM	04	;Loads 4 into the
0349	8D F8 03	STA	03F8	;COUNT 2 location (1016)
034C	A9 66	LDAIM	66	;CHR$(166) in A
034E	A2 01	LDXIM	01	;Increment in X
0350 LOOP1	81 00	STAIX	00	;CHR$(166) to 32768
0352	20 AC 03	JRS	INCADD	;Gosub increment address
0355	CE F9 03	DEC	COUNT1	;LOOP1 allows for 840
0358	D0 F6	BNE	LOOP1	;repeats of CHR$(166) at
035A	CE F8 03	DEC	COUNT2	;successive screen locations
035D	D0 F1	BNE	LOOP1	;i.e., 21 lines.
035F	60	RTS		;Return to Basic program
0360	A9 30	LDAIM	30	;Stores address 32816
0362	85 01	STAZ	01	;in zero-page locations
0364	A9 80	LDAIM	80	;01 and 02
0366	85 02	STAZ	02	;
0368	A9 0A	LDAIM	0A	;Loads 10 into the
036A	8D F8 03	STA	03F8	;COUNT 2 location (1016)
036D LOOP2	A9 0C	LDAIM	0C	;Number of blanks in string
036F	20 9A 03	JSR	BLANK	;Gosub blank-string printer
0372	A2 44	LDXIM	44	;Load X with the required offset
0374	20 AC 03	JSR	INCADD	;Move to the next address
0377	CE F8 03	DEC	COUNT2	;LOOP2 allows for 10 repeats
037A	D0 F1	BNE	LOOP2	;of the 12 blank string
037C	60	RTS		;Return to Basic program
037D	A9 4A	LDAIM	4A	;Stores address 32842
037F	85 01	STAZ	01	;in zero-page locations
0381	A9 80	LDAIM	80	;01 and 02
0383	85 02	STAZ	02	;
0385	A9 09	LDAIM	09	;Loads 9 into the
0387	8D F8 03	STA	03F8	;COUNT 2 locations (1016)
038A LOOP3	A9 05	LDAIM	05	;Number of blanks in string
038C	20 9A 03	JSR	BLANK	;Gosub blank-string printer
038F	A2 4B	LDXIM	4B	;Load X with the required Offset
0391	20 AC 03	JSR	INCADD	;Move to the next address
0394	CE F8 03	DEC	COUNT2	;LOOP3 allows for nine repeats
0397	D0 F1	BNE	LOOP3	;of the 5 blank string
039A	60	RTS		;Return to the Basic program
039A BLANK	8D F9 03	STA	03F9	;Set COUNT 1
039D	A9 20	LDAIM	20	;Put CHR$(32) in A
039F	A2 01	LDXIM	01	;Put increment of 1 in X
03A1 LOOP4	81 00	STAIX	00	;Print blank at indirect indexed address
03A3	20 AC 03	JSR	INCADD	;Move to the next address
03A6	CE F9 03	DEC	COUNT1	;LOOP4 counts the number of
03A9	D0 F6	BNE	LOOP4	;Blanks passed to it from main program
03AB	60	RTS		;Return
03AC INCADD	A8	TAY		;Save current value of A in Y
03AD	18	CLC		;Set 'Carry' to zero
03AE	8A	TXA		;Put X in A
03AF	65 01	ADC	01	;Add A to zero page 01; store in A
03B1	90 02	BCC	CLEAR	;Check 'Carry' and add 1 to
03B3	E6 02	INCZ	02	;Zero page 02 if set
03B5 CLEAR	85 01	STAZ	01	;Put new address in zero page 01
03B7	98	TYA		;Recover value of A
03B8	60	RTS		;Return
03B9	A9 48	LDAIM	48	;Stores address 33608
03BB	85 01	STAZ	01	;in zero-page locations
03BD	A9 83	LDAIM	83	;01 and 02
03BF	85 02	STAZ	02	;
03C1	A902	LDAIM	02	;Puts 2 into the
03C3	8D F8 03	STA	03F8	;COUNT 2 location 1016
03C6 LOOP5	A9 50	LDAIM	50	;Number (80) of blanks required
03C8	20 9A 03	JSR	BLANK	;Gosub blank-string printer
03CB	CE F8 03	DEC	COUNT2	;LOOP5 gives two times 80 blanks
03CE	D0 F6	BNE	LOOP5	;i.e., four lines at the bottom of the screen
03D0	60	RTS		;Return to Basic program

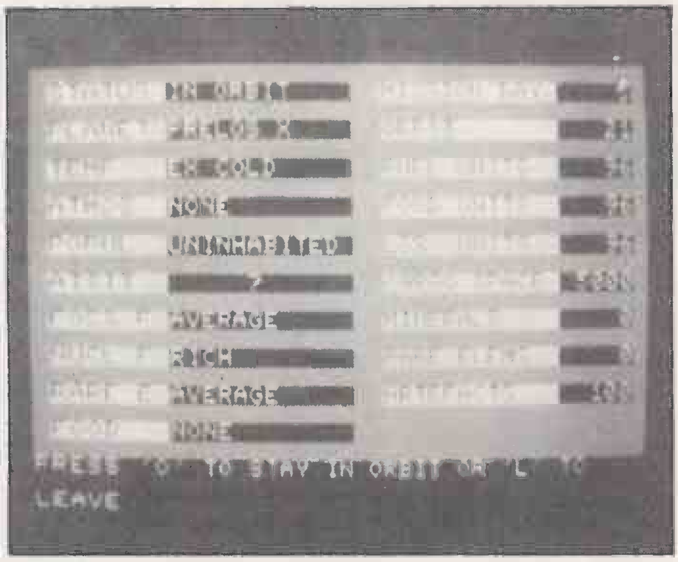

Figure 1.

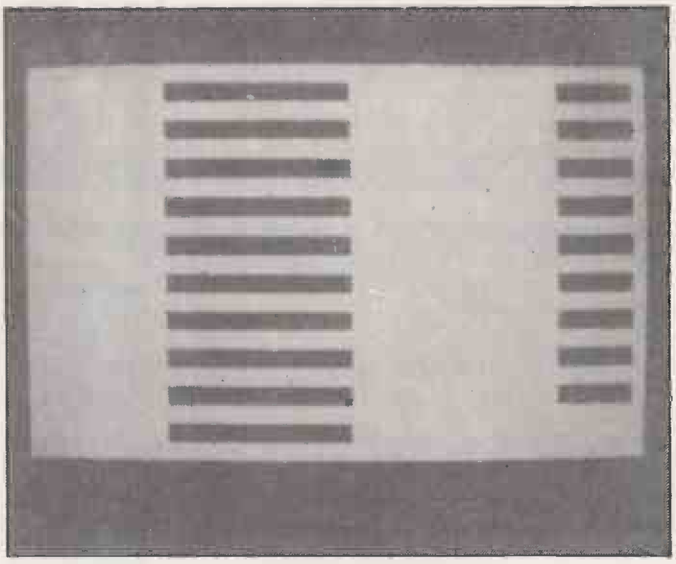

Figure 2.

a version for the new ROM and will give you conversion details.

As you will find out when you run the program, you are presented with a good deal of information about the planet you are orbiting and one of the first things I considered when designing the game was how to present this information. I decided on a display that looks like figure 1 which is a display from early in the game. Initially, I implemented this in Basic and did so by first considering the basic grid, which is shown in figure 2. This can be thought of as being in three sections: firstly, there is the background, which consists of 21 lines of CHR$(166) — the shifted & graphics character; next, we have 10 windows each consisting of 12 blank spaces and separated by two lines; finally, there are nine other windows of five blanks each.

Basic too slow

Looked at in this way, the display can be described in programming terms by a series of For . . . Next loops, with appropriate movements of the cursor to start the action in the proper place and put the correct gaps between the windows. The two sets of windows need to be thought of separately, as they will carry two different sets of information — those on the left refer to the planet you are orbiting, while those on the right concern your spaceship — and they will be updated at various times in the program.

My first attempt at the program produced the display using Basic. However, it soon became apparent that this was less than satisfactory for two reasons. One was the pressure on memory space to give me sufficient scope for all the variable factors and complexities I wished to introduce. The other was the time it took the program to print the display. This would not have been important had I needed to print it only once, but it is an important part of the program that you use the screen for several other read-outs when you are exploiting a planet.

The display of several seconds while the display was reconstructed was becoming tedious and it soon became obvious that I should try to develop a machine-code routine which would suit my purpose. If I could also lodge this routine in the second cassette buffer — a useful piece of spare memory — I would also free more memory for the game. Up to this point I had not tried any serious machine-code programming, so this was to be a voyage of discovery. The fact that I was successful should encourage other tyros to have a go and improve the speed of their programs.

First, for those who are not familiar with what is meant by machine code, a few words on how your microprocessor receives its instructions. An eight-bit microprocessor, such as the 6502 at the heart of the Pet, 'understands' words consisting of eight binary digits, from 00000000 to 11111111. These words can represent numbers or instructions and will be appropriately interpreted by the microprocessor according to their context.

Although the microprocessor can only deal with numbers in this form, it is an inconvenient form for a human operator to have to work and various high-level languages are available, such as Basic. These need to be interpreted into a series of numbers for the microprocessor and it is this process that makes a program written in Basic run much more slowly than one applied directly to the microprocessor.

Machine-code programs consist, therefore, of a series of eight-bit binary words. Numbers like 01001011, are, however, cumbersome for a human and not easily understood at a glance. Instead, the same numbers can be expressed in two other ways, decimal and Hexadecimal. In decimal notation our range of eight-bit numbers lies between 0 and 255, inclusive, and this is the form in which the machine-code program appears in the Data statements in the Basic program.

Binary words can also be considered as consisting of two four-bit numbers in the range 0000 to 1111. This range can be represented by 16 symbols, the numbers 0 to 9 and the letters A to F. Thus each eight-bit word is represented by a two-digit Hexadecimal — base 16 — number, in the range 00 to FF. This Hexadecimal notation is extended to higher numbers. For example, the location 826 in memory can also be referred to as 033A, meaning 0 times 16^3 plus 3 times 16^2 plus 3 times 16 plus A(10) times 1.

Hex instructions

This Hexadecimal form is used in the listing of the machine-code program given in table 1. Remember, these two-digit words can be instructions, addresses or actual numbers — it is up to the microprocessor to decide which according to the context.

Now let us consider the machine-code itself. Eventually, it will be placed in memory from locations 826 to 976 — 033A to 03D0 — and these memory locations are listed down the left-hand column of table 1. In the next column, at various points in the program, the names and start positions of particular sections of the program are given to which a jump has to be made. These labels are an aid to understanding and are not entered as part of the program. The next three columns are the program itself.

The first of these three columns contains instruction words and these instructions may be followed by 0, 1 or 2 other numbers. Some instructions stand alone and need nothing after them; others refer to a number in the range 0 to 255 and have one number after them, while others refer to a full address needing a four-digit Hexadecimal number. We will see examples of all the types as we study the program.

(continued on page 85)

(continued from page 83)

Next in table 1, we have another version of the program, using mnemonic symbols which are more easily interpreted by the reader than the Hexadecimal numbers. This form is known as assembly language and can be used when writing machine-code. In this case, I wrote the original program in this form and then translated it into the Hexadecimal and decimal listings later, but it is also possible to use an assembler program which will allow you to compile the machine-code directly into memory by entering the mnemonic symbols into your computer.

The assembly listing is given to allow you to follow the working of the program more easily, and to this end there are a number of remarks included on the right of table 1, explaining what is happening.

Program sections

The program consists of four main sections, each a program in its own right, plus two subroutines. 033A to 035F contain a program for printing a backing of 21 lines of CHR$(166) and is called by SYS 826. 0360 to 037C print 10 strings of 12 blank spaces — CHR$ (32) — in the appropriate positions on the display and is called by SYS 864. 037D to 0399 prints nine strings of five blank spaces towards the right of the display and is called by SYS 893.

Next in the program are two subroutines: 039A to 03AB is known as Blank and prints blank spaces for the number of times it is told by the program that calls it; 03AC to 03B8 is labelled INCADD and is used to modify the address of the screen location to that needed for the next printing. Finally, 03B9 to 03D0, which was added as an afterthought after the successful development of the other routines, is used to clear the bottom of the screen by printing four rows of blanks on lines 22 to 25.

The significant feature of the Pet that allows machine-code routines like these to be used is the screen appearing to the system as just another area in memory. You will probably be already familiar with this concept if you have ever used Poke and Peek. The screen information is allocated a 1K block of memory, starting at 8000 — 32768 — and we can put a symbol directly on to the screen by finding the number which represents that symbol and then Poking it into the correct memory location.

For example, POKE 32768, 102 puts a shifted & symbol into the top left-hand corner of the screen — try it. Note. however, that this number for Poke is not always the same as the CHR$ number — the same symbol can be seen using PRINT CHR$ (166) and our machine-code program uses CHR$ (166) and CHR$(32), a blank space, which correspond to the Hexadecimal — decimal — numbers of 66(102) and 20(32).

Putting one of these symbols on to the screen would be easy if there were an instruction for the microprocessor which said: "Put N into memory location M". However, such an instruction would contain two unknowns, M and N, and this is not possible. Instead, we have to use intermediate registers to store one of the unknowns. The registers we have available in the 6502 are the A, X and Y registers.

They are eight-bit registers and differ in their intended uses. The A register is the arithmetic register and there are instructions to allow you to modify its contents in ways which are arithmetic operations. The X and Y registers are index registers and can be used in other ways.

To return to the problem of putting N into M, one way to do this is to put N into A — load A immediately with N — and then transfer the contents of A to M — store A at M. There are instructions for this and, in fact, we use such a sequence starting at 0342, where we store the Hexadecimal number 48 in 03F9. As far as storing numbers in screen locations is concerned, we must bear in mind that these locations must be altered after each print action.

Consequently, a more indirect approach is required, using a form such as: "Store the contents of A at a memory location given by the contents of p". This allows us to modify the contents of p so that the next location's position is stored there. This is the approach the program uses and the first consideration is where to have p. We can consider the memory available in terms of blocks — for example, 1K blocks — which might seem a convenient form of subdivision.

There is, however, a smaller subdivision which is also useful. This is the amount of memory which can be defined by one eight-bit number; 00 to FF gives a total of 256 addresses and this is known as a page. The easiest page to define is the one from 0000 to 00FF, known as the zero page and there are several instructions which can be given to the 6502 to direct it to the zero page.

For this reason, much of the zero page is occupied with the operating system of the Pet, but we can borrow two locations which will not be needed. Zero-page locations 01 and 02 are normally used to store a reference address for the USR function. This is not involved in our program so we will store the relevant screen location in these two spaces.

The least-significant part of the address goes in 01 and the most-significant part in 02. This is done initially by the section of a program from 033A to 0341, where we first load 00 directly into the A register and then store the contents of A at zero-page address 01, followed by loading A with 80 and storing the contents of A at zero page 02.

The two numbers we store next are counters to determine the number of times we print the shifted & symbol. We want to do this for 21 lines of the screen; 21 times 40 = 840. However, a single eight-bit number gives us a count of only 256, so we need to make three counts of 256 — which equals 768 — plus the remainder of 72.

Now we have the first screen location loaded into the zero page and have set our counters, we load A with the symbol to be printed, CHR$(166) and the X register with the increment in the screen address we want. Since we are printing CHR$(166) at every location in the first 21 lines, the increment is simply 1.

Now we give the print command using an instruction which will find the address we stored in the zero page. STAIX 00 tells the microprocessor to store the contents of A at an address which will be found in the zero-page location 00 plus the contents of the X register (1).

Having found the address 8000 — 32768 — the contents of A are now stored there. Note, however, that the A register will not be cleared, but will still have 66 — 102 decimal — left in it. The overall result of this process is to print CHR$(166) in the top left-hand corner of the screen. We now need to increment the address in 01 and 02, before the next print command and this is the purpose of the subroutine INCADD to which the program is now directed.

Arithmetic functions

In INCADD, we will need to carry out an arithmetic operation involving the use of the A register, but we have not finished with the contents of the A register, so the first step is to find a temporary place to store the A register contents. The Y register is not needed for anything else, so we use this as it needs only a single instruction TAY.

The arithmetic function we are to use involves a flag which is set to 1 if the A register contents are increased above FF. Although the A register would go from FF to 00, the carry flag would be set to show that this has occurred.

Now we put the desired increment into A (TXA) and add to it the contents of zero page 01. Eventually, after this subroutine has been visited several times, this would result in A exceeding FF and the carry flag would be set. If this should happen then zero page 02 is incremented by 1, but if it does not, this INCZ instruction is bypassed.

The BCC instruction tells the program to go forward two steps if the carry flag stays clear. The new contents of A are stored at zero page 01, the old contents of A — CHR$(166) — are transferred back from Y and the main program is rejoined at 0355.

So far, we have printed CHR$(166) at 32768 and increased the indirect address in

(continued on next page)

(continued from previous page)
the zero page to 32769. We will now print at this new address and make another increment in the address and so on. We must also keep track of how many times we do this so that we end after 840 such actions. That is where the two counters enter. We first decrease COUNT 1 by 1, from decimal 72 to 71 and then test to see if this resulted in a zero answer — another flag is used for this.

Obviously, it does not happen this time so the program is told to branch if not equal to zero. This branch instruction is followed by a number, F6. Branch instructions allow for forward and backward branching. We use 00 to 7F to indicate forward branching and FF down to 80 for reverse branches. FF means one step back, FE two steps and so on. Thus F6 means 10 steps and we need to know from where to count.

After the microprocessor has read F6, its program counter will have stepped on to the next position, so one step back takes it back to the F6, two steps to D0, etc. — 10 steps takes it back to 0350, the instruction to print CHR$(166) at the next screen location. This process continues until COUNT 1 reaches zero when, instead of branching back, the program decreases COUNT 2 from 4 to 3 and since this does not result in zero, branches back 15 steps to continue printing.

The next decrement of COUNT 1 results in its going from 00 to FF and the program will, therefore, go through another 256 cycles of printing before COUNT 1 again reaches 00 and COUNT 2 is decreased to 2. After another two sets of 256 cycles, making a grand total of 72 + 256 + 256 + 256 = 840, COUNT 2 reaches zero and the RTS instruction is reached which returns control to the Basic program.

The other three programs are all similar in that they print a series of blank spaces. The first two, starting at 0360 and 0370, print out strings of blanks, separated by two lines on the screen. The sum of the length of the string and the increment needed to locate the next string has to be decimal 80.

The first stage is to load the first address that we will need into the zero-page locations 01 and 02. Then we enter the number of times we want the string repeated in COUNT 2. Next, we put the length of the string into the A register and we are ready to call subroutine Blank.

This starts at 039A and firstly stores A in COUNT 1. Then it reloads A with 20 — CHR$(32) — the number which represents a blank space, and loads X with 1, as this will be the initial increment required. STAIX 00 has the effect of printing a blank at the first memory location indicated by the contents of zero page 01 and 02.

Subroutine INCADD is used to step the screen location on one and this process is repeated for the number of blanks required, as determined by the contents of COUNT 1. Once COUNT 1 reaches zero, we exit the loop and return to the main program at 0372.

Back at 0372, we load X with the increment needed to move from the screen position at the end of the string to the start of the next string, two lines further down the screen. The offset is given by subtracting the length of the string from 80. Then we use INCADD to increment the screen address in the zero page. The loop controlled by COUNT 2 will allow for the string of blanks to be repeated the required number of times. Program 037D operates in an identical manner to this, while 03B9 involves only the use of the BLANK subroutine to print out two strings of 80 blanks.

That then is the machine-code routine to be used in Star System. It is contained in the Data statements in lines 120 to 190 of the Basic program. In this program, they will be put on to the data tape in line 600 and in the next program they will be transferred from the tape into the second cassette buffer. If you wish to check that you have entered these Data statements correctly, first enter the program down to line 190 and save it. Next add the

```
192 FOR I = 1 TO 22: READ N$: NEXT
194 FOR I = 826 TO 976: READ D: POKE
    I,D: NEXT
196 SYS 826: SYS 864: SYS 893: SYS 953
198 WAIT 59410,4,4
```

This should result, when run, in a display like figure 2, and the program will end to give Ready when Space is pressed. Delete the additional lines and continue entering the program.

For those of you with new ROMs, here are the necessary modifications:

Line 560 Delete the two POKE commands
Delete lines 1110 to 1140
Delete GOSUB 1110 in lines 570, 580, 590, 600, 610, 620

As you may realise, the purpose of these additions for the old ROMs are to give a more reliable Data Tape, with correctly separated blocks of data and a correct header at the start of the tape.

Next month, we will give you the game program itself.

```
READY.

 10 REM**      *STAR SYSTEM*      **
 20 REM**                         **
 30 REM**A SPACE EXPLORATION GAME **
 40 REM**       IN TWO PARTS      **
 50 REM** FOR AN 8K PET (OLD ROM) **
 60 REM** BY R.C.MERRY.  JAN 1981 **
 70 REM*****************************
 80 REM**SEE ARTICLE FOR CONVERSION*
 90 REM**        FOR NEW ROM      **
100 DATA VARGOS,LEXON,MIROS,VEGA,GORSIK,HYLOG,PRELOS,DARIX,RENDOR,SIROLA
110 DATA I,II,III,IV,V,VI,VII,VIII,IX,X,XI,XII
120 DATA 169,0,133,1,169,128,133,2,169,72,141,249,3,169,4,141,248,3,169,102
130 DATA 162,1,129,0,32,172,3,206,249,3,208,246,206,248,3,208,241,96,169,48
140 DATA 133,1,169,128,133,2,169,10,141,248,3,169,12,32,154,3,162,68,32,172,3
150 DATA 206,248,3,208,241,96,169,74,133,1,169,128,133,2,169,9,141,248,3,169,5
160 DATA 32,154,3,162,75,32,172,3,206,248,3,208,241,96,141,249,3,169,32,162
170 DATA 1,129,0,32,172,3,206,249,3,208,246,96,168,24,138,101,1,144,2,230,2
180 DATA 133,1,152,96,169,72,133,1,169,131,133,2,169,2,141,248,3,169,80,32
190 DATA 154,3,206,248,3,208,246,96
200 DATA 100,100,100,5000,0,0,100,1
210 DIMP$(12)
220 PRINT"STAR SYSTEM CREATION
230 PRINT"THIS PROGRAM CREATES THE STAR SYSTEM
240 PRINT"TO BE USED IN YOUR GAME. IF YOU WANT
250 PRINT"THE FULL INSTRUCTIONS, PRESS 'Y'; PRESS
260 PRINT"ANY OTHER KEY TO OMIT THESE.
270 R=RND(1):GETR$:IFR$=""THEN270
280 IFR$="Y"THENGOSUB690
290 PRINT"PLEASE WAIT WHILE THE SYSTEM IS CREATED
300 R=INT(10*RND(TI)+1):FORI=1TOR:READS$:NEXT
310 IFR=10THEN330
320 FORI=R+1TO10:READD$:NEXT
330 N=INT(5*RND(1)+8):FORI=1TON
340 READF$:P$(I)=S$+" "+P$
350 IFLEN(P$(I))<12THENP$(I)=P$(I)+" ":GOTO350
360 T=INT(I*6/N+1):P$(I)=P$(I)+RIGHT$(STR$(T),1)
370 E=INT(5*RND(1)+1):P$(I)=P$(I)+RIGHT$(STR$(E),1)
380 IFT<2ORT>6ORE=5THENP=8:GOTO410
390 IFRND(1)>.2THENP=8:GOTO410
400 P=INT(7*RND(1)+1)
410 P$(I)=P$(I)+RIGHT$(STR$(P),1)
420 P$(I)=P$(I)+"6"
430 FORJ=1TO3:M=INT(3*RND(1)+1):P$(I)=P$(I)+RIGHT$(STR$(M),1):NEXT
440 IF(T=3ORT=5)AND(E=3ORE=4)THENF$="2":GOTO470
450 IFT=4AND(E=3ORE=4)THENF$="3":GOTO470
460 F$="1"
470 P$(I)=P$(I)+F$+"00"
480 O=O+INT(3*RND(1)+1):O$=STR$(O)
490 IFLEN(O$)=3THENO$=RIGHT$(O$,2):GOTO510
500 O$="0"+RIGHT$(O$,1)
510 P$(I)=P$(I)+O$:NEXT
520 IFN=12THEN540
530 FORI=N+1TO12:READD$:NEXT
540 PRINT"PLEASE LOAD A BLANK DATA TAPE. PRESS
550 PRINT"SPACE WHEN READY.":WAIT59410,4,4
560 POKE244,2:POKE243,122:OPEN1,1,1
570 PRINT#1,S$:GOSUB1110
580 PRINT#1,N:GOSUB1110
590 FORI=1TON:PRINT#1,P$(I):GOSUB1110:NEXT
600 FORI=826TO984:READM:PRINT#1,M:GOSUB1110:NEXT
610 OB=INT(35*RND(1)+5):PRINT#1,OB:GOSUB1110
620 FORI=1TON:PRINT#1,0:GOSUB1110:NEXT
630 CLOSE1
640 PRINT"THE DATA FOR YOUR GAME IS NOW READY.
650 PRINT"THE STAR SYSTEM IS CALLED "S$" AND
660 PRINT"THERE ARE"N"PLANETS IN IT. REWIND YOUR
670 PRINT"DATA TAPE, LOAD AND RUN THE GAME PROGRAM
680 END
690 PRINT"YOU ARE THE COMMANDER OF A DEEP-SPACE
700 PRINT"EXPLORATION STARSHIP. YOUR MISSION IS TO
710 PRINT"EXPLORE THE STAR SYSTEM AT WHICH YOU
720 PRINT"ARRIVE. WHEN YOU COME OUT OF WARP DRIVE
730 PRINT"YOU WILL HAVE LIMITED AMOUNTS OF FUEL,
740 PRINT"FOOD AND LIFE SUPPORT. ONE OF YOUR TASKS
750 PRINT"IS TO COLLECT SUFFICIENT OF THESE ITEMS
760 PRINT"FROM THE PLANETS IN THE SYSTEM TO RETURN
770 PRINT"TO EARTH. YOU NEED AT LEAST 1000 UNITS
780 PRINT"OF EACH. PRESS SPACE AT THE END OF EACH
790 PRINT"PAGE OF INSTUCTIONS TO CONTINUE";:WAIT59410,4,4
800 PRINT"SINCE THIS IS A GAME OF EXPLORATION - A
810 PRINT"JOURNEY INTO THE UNKNOWN - YOU ARE LEFT
820 PRINT"TO DISCOVER FOR YOURSELF HOW THE VARIOUS
830 PRINT"FACTORS IN THE GAME INTERRELATE (E.G.
840 PRINT"HOW ATMOSPHERE AND TEMPERATURE AFFECT
850 PRINT"MINING CONDITIONS AND EFFICIENCY). YOU
860 PRINT"WILL EARN POINTS FOR ESTABLISHING GOOD
870 PRINT"RELATIONSHIPS WITH CONTACTED RACES, WHO
880 PRINT"WILL RANGE FROM PRIMITIVE TO SUPER-RACE
890 PRINT"(YOU ARE AT THE STAR-TRAVEL LEVEL).
900 PRINT"IF THEY LIKE YOU THEY MAY GIVE YOU GIFTS
910 PRINT"AND YOU CAN INFLUENCE THEM WITH GIFTS.":WAIT59410,4,4
920 PRINT"ONE OF YOUR TASKS IS TO SURVEY THE STAR
930 PRINT"SYSTEM. A SHORT SURVEY OF A PLANET CAN
940 PRINT"BE DONE BY STAYING IN ORBIT FOR TWO DAYS
950 PRINT"WHILST A COMPLETE SURVEY TAKES OVER TEN
960 PRINT"DAYS. YOU SHOULD DO A SHORT SURVEY ON
970 PRINT"ALL THE PLANETS AND A COMPLETE SURVEY
980 PRINT"SHOULD BE DONE OF INHABITED PLANETS.
990 PRINT"THE ON-BOARD COMPUTER WILL AUTOMATICALLY
1000 PRINT"SURVEY THE PLANETS AND SEND THE RESULTS
1010 PRINT"BACK TO EARTH.":WAIT59410,4,4
1020 PRINT"WHEN YOU ARE READY TO RETURN TO EARTH,
1030 PRINT"OR IF YOU WISH TO TAKE A REST, YOU CAN
1040 PRINT"ENTER YOUR DESTINATION AS '99'. THIS
1050 PRINT"WILL GIVE YOU THE CHOICE OF SAVING THE
1060 PRINT"CURRENT POSITION ON A DATA TAPE, OR OF
1070 PRINT"ADDING UP YOUR POINTS. THERE IS A LARGE
1080 PRINT"PENALTY FOR ATTEMPTING TO RETURN TO
1090 PRINT"EARTH WITH INSUFFICIENT SUPPLIES.":WAIT59410,4,4
1100 FORI=1TO10:GETR$:NEXT:RETURN
1110 IFPEEK(625)<180THEN RETURN
1120 POKE59411,53:T=TI
1130 IFTI<12THEN1130
1140 POKE59411,61:RETURN
```

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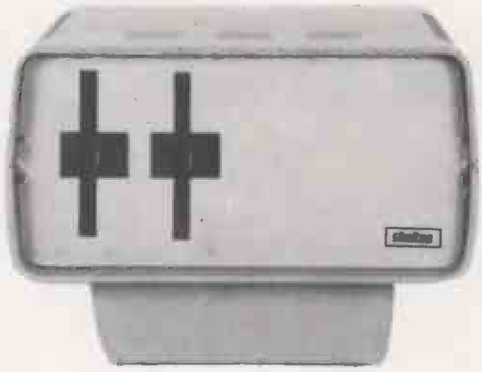

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Cassette 1 – Games

For ZX81 (and ZX80 with 8K BASIC ROM)

ORBIT – your space craft's mission is to pick up a very valuable cargo that's in orbit around a star.

SNIPER – you're surrounded by 40 of the enemy. How quickly can you spot and shoot them when they appear?

METEORS – your starship is cruising through space when you meet a meteor storm. How long can you dodge the deadly danger?

LIFE – J. H. Conway's 'Game of Life' has achieved tremendous popularity in the computing world. Study the life, death and evolution patterns of cells.

WOLFPACK – your naval destroyer is on a submarine hunt. The depth charges are armed, but must be fired with precision.

GOLF – what's your handicap? It's a tricky course but you control the strength of your shots.

Cassette 2 – Junior Education: 7-11-year-olds

For ZX81 with 16K RAM pack

CRASH – simple addition – with the added attraction of a car crash if you get it wrong.

MULTIPLY – long multiplication with five levels of difficulty. If the answer's wrong – the solution is explained.

TRAIN – multiplication tests against the computer. The winner's train reaches the station first.

FRACTIONS – fractions explained at three levels of difficulty. A ten-question test completes the program.

ADDSUB – addition and subtraction with three levels of difficulty. Again, wrong answers are followed by an explanation.

DIVISION – with five levels of difficulty. Mistakes are explained graphically, and a running score is displayed.

SPELLING – up to 500 words over five levels of difficulty. You can even change the words yourself.

Cassette 3 – Business and Household

For ZX81 (and ZX80 with 8K BASIC ROM) with 16K RAM pack

TELEPHONE – set up your own computerised telephone directory and address book. Changes, additions and deletions of up to 50 entries are easy.

NOTE PAD – a powerful, easy-to-run system for storing and retrieving everyday information. Use it as a diary, a catalogue, a reminder system, or a directory.

BANK ACCOUNT – a sophisticated financial recording system with comprehensive documentation. Use it at home to keep track of 'where the money goes,' and at work for expenses, departmental budgets, etc.

Cassette 4 – Games

For ZX81 (and ZX80 with 8K BASIC ROM) and 16K RAM pack

LUNAR LANDING – bring the lunar module down from orbit to a soft landing. You control attitude and orbital direction – but watch the fuel gauge! The screen displays your flight status – digitally and graphically.

TWENTYONE – a dice version of Blackjack.

COMBAT – you're on a suicide space mission. You have only 12 missiles but the aliens have unlimited strength. Can you take 12 of them with you?

SUBSTRIKE – on patrol, your frigate detects a pack of 10 enemy subs. Can you depth-charge them before they torpedo you?

CODEBREAKER – the computer thinks of a 4-digit number which you have to guess in up to 10 tries. The logical approach is best!

MAYDAY – in answer to a distress call, you've narrowed down the search area to 343 cubic kilometers of deep space. Can you find the astronaut before his life-support system fails in 10 hours time?

Cassette 5 – Junior Education: 9-11-year-olds

For ZX81 (and ZX80 with 8K BASIC ROM)

MATHS – tests arithmetic with three levels of difficulty, and gives your score out of 10.

BALANCE – tests understanding of levers/fulcrum theory with a series of graphic examples.

VOLUMES – 'yes' or 'no' answers from the computer to a series of cube volume calculations.

AVERAGES – what's the average height of your class? The average shoe size of your family? The average pocket money of your friends? The computer plots a bar chart, and distinguishes MEAN from MEDIAN.

BASES – convert from decimal (base 10) to other bases of your choice in the range 2 to 9.

TEMP – Volumes, temperatures – and their combinations.

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NPV AT 12.5 % IS-109.62

P	CAPITAL	WORKING CAPITAL	REVENUE	TAXATION	CASH FLOW	NPV	CUM NPV
00	- 3000	+ 1000	+ 50	+	- 1950	- 1950	- 1950
01	- 500	- 500	+ 150	+	- 850	- 801	- 2751
02	+	- 300	+ 275	+ 1475	+ 1450	+ 1289	- 1462
03	+	- 250	+ 350	+	+ 100	+ 84	- 1378
04	+	- 250	+ 350	- 300	- 200	- 158	- 1536
05	+	+	+ 350	+	+ 350	+ 261	- 1275
06	+	+	+ 400	- 300	+ 100	+ 70	- 1205
07	+	+	+ 450	+	+ 450	+ 298	- 907
08	+	+	+ 500	- 400	+ 100	+ 62	- 845
09	+ 750	+ 300	+ 200	+	+ 1250	+ 736	- 109
	- 2750	+	+ 3075	+ 475	+ 800	- 109	

NPV AT 10.5 % IS 4.65

P	CAPITAL	WORKING CAPITAL	REVENUE	TAXATION	CASH FLOW	NPV	CUM NPV
00	- 3000	+ 1000	+ 50	+	- 1950	- 1950	- 1950
01	- 500	- 500	+ 150	+	- 850	- 809	- 2759
02	+	- 300	+ 275	+ 1475	+ 1450	+ 1312	- 1447
03	+	- 250	+ 350	+	+ 100	+ 86	- 1361
04	+	- 250	+ 350	- 300	- 200	- 164	- 1525
05	+	+	+ 350	+	+ 350	+ 273	- 1252
06	+	+	+ 400	- 300	+ 100	+ 74	- 1178
07	+	+	+ 450	+	+ 450	+ 317	- 861
08	+	+	+ 500	- 400	+ 100	+ 67	- 794
09	+ 750	+ 300	+ 200	+	+ 1250	+ 798	+ 4
	- 2750	+	+ 3075	+ 475	+ 800	+ 4	

Thus - the True Rate of Return on this project is 10.5%

Making capital out of appraisal methods

Careful financial appraisal of capital expenditure and investment are often thought to be necessary only in very large companies which spend large sums of money. Yet even the smallest business could and should employ adequate appraisal methods — both for examining potential investment opportunities and for comparing alternative investments. EG Acraman reports.

AN EXAMPLE of the application of such appraisal methods might be where a business must choose between two machines, one of which is more expensive than the other but has a greater capacity and longer life. Evaluating the nett present value, NPV, of the additional cost could solve the problem of which to choose.

One method which can give seriously-misleading results is the "payback" method which judges comparative investments on the length of time taken to recover the initial outlay. This method pays no regard to the timing of cash-flows or the total income from the project over its useful life.

The technique currently accepted as most efficient is that of discounted cash-flow, DCF. When a business makes an investment, it pays cash today in the expectation of receiving more in the future. This cash-flow and the timing of it is the basis of the appraisal. All "book" adjustments such as depreciation, profit or loss on the sale of an asset, etc., are ignored, but all cash-flows — even notional ones — should be brought into account.

Thus, if an existing asset — such as a building — is to be utilised in a project being evaluated, the cash value of that asset should be charged to the project. Similarly, requirements for working capital, tax reliefs on purchase of plant, etc., should be included in the calculations.

The discounted-cash-flow method recognises the importance of the timing of cash flow, i.e., at a discount rate of 10 percent, £10 to be received in one year is worth only £9.09 today, and £10 to be received in four years is worth only £6.83 today.

Thus, to evaluate a project by the DCF method, the cash-flows throughout its life are estimated and discounted back to the NPV at the desired rate of return. The discount rate at which the NPV is zero is the true rate of return on the project.

The program will first ask for the name of the project, the number of periods per annum, i.e., one for annual rests, four for quarterly, 12 for monthly etc., and the total number of years concerned.

The cash-flows for each period — + for income, — for expenditure — are then input under the categories: capital expenditure, working capital, revenue and taxation. Finally, the rate of discount to be applied is entered. The Pet then displays the NPV of the project at the rate of discount given. You then have a choice of:

- Trying another discount rate. This will recalculate the NPV of the cash-flows already entered, using the revised rate of discount.
- Determining the true rate of return. If the total NPV returned was positive, this indicates that the true rate of return is higher than the rate quoted. Conversely, if the NPV was negative, the true rate of return is lower than that quoted. To calculate the true rate of return, i.e., that at which the NPV is zero or as close to zero as possible, the rate already in the variable R is increased/decreased by 0.1 and the calculations repeated in a loop until the total NPV is 5 or less. This value can be amended — line 470 — to suit particular requirements, but if it is set too low and the figures involved in the project are large, you may be caught up in a perpetual loop. On the other hand, if it is set too high, you could obtain a slightly erroneous answer.
- Changing any entry. To test the value of a project under varying circumstances, or to test the sensitivity of the result to possible changes in specific items, it is often useful to have the answers to "what if?" questions. This facility enables you to revise one particular figure without having to re-enter every single item of data.
- Displaying the table on the screen, or printing it out. The program is written to print out to a Commodore printer, and the printout gives, for each period and the total, the four figures input plus the total cash-flow, the NPV and the cumulative NPV to the period. The cumulative NPV indicates the break-even point, i.e., the period in which the sign changes from negative to positive.

The screen display, due to limitations of size on the 40-column screen, consolidates the first two columns and omits the last one.

```
100 REM**INVESTMENT APPRAISAL**
110 REM**USING DISCOUNTED CASH FLOW**
120 REM**COPYRIGHT(C)-E.G.ACRAMAN**
130 REM**1STJANUARY 1981**
140 PRINT"DISCOUNTED CASH FLOW"
150 REM**DIM FOR TOTAL NUMBER OF PERIODS**
160 DIMB(60),O(60),R(60),P(60),C(60),T(60),V(60)
170 INPUT"PROJECT NAME";P$
180 INPUT"HOW MANY PERIODS PER ANNUM ";A
190 INPUT"HOW MANY YEARS";B:P=A*B
200 FORX=0TOP-1:PRINT"PERIOD :"X:INPUT"CAPITAL EXPENDITURE ";B(X)
210 INPUT"WORKING CAPITAL ";P(X):INPUT"REVENUE ";O(X)
220 INPUT"TAXATION ";R(X):NEXT
230 B1=0:P1=0:O1=0:C1=0:R2=0:T1=0:X1=0
240 FORX=0TOP-1
250 C(X)=B(X)+P(X)
260 T(X)=C(X)+O(X)+R(X)
270 B1=B1+B(X):P1=P1+P(X):O1=O1+O(X):C1=C1+C(X)
280 R2=R2+R(X):T1=T1+T(X):NEXT
290 INPUT"ANNUAL RATE OF DISCOUNT ";R
300 X1=0
310 R1=(R*.01):GOSUB460
320 PRINT"N P V AT "R"% IS"INT(X1*100+.5)/100
```

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```
 330 PRINT"PRESS ANY KEY TO CONTINUE"
 340 GETX$:IFX$=""GOTO340
 350 PRINT"□▣DO YOU WISH TO -"SPC(67)"1)  TRY ANOTHER RATE OF DISCOUNT"
 360 PRINT"▣   2)  KNOW THE RATE OF RETURN"
 370 PRINT"▣   3)  CHANGE ANY ENTRY"
 380 PRINT"▣   4)  DISPLAY ON SCREEN"SPC(59)"5)  PRINT OUT THE TABLE"
 390 PRINT"▣   6)  END",,,"▣ENTER COMMAND BY NUMBER (1-6) ?"
 400 GETC$:IFC$<"1"ORC$>"6"GOTO400
 410 PRINT"□":ONVAL(C$)GOTO290,420,520,680,760,940
 420 R=R+SGN(X1+1)/10
 430 R1=(R*.01)
 440 X1=0:GOSUB460:GOTO470
 450 REM**CALCULATE NPV OF CASH FLOW**
 460 FORX=0TOP-1:V(X)=T(X)/((1+R1)↑(X/A)):X1=X1+V(X):NEXT:RETURN
 470 IFABS(X1)>5GOTO420
 480 PRINT"RATE OF RETURN IS "R"%"
 490 PRINT"PRESS ANY KEY TO CONTINUE"
 500 GETX$:IFX$=""GOTO500
 510 GOTO350
 520 PRINT"□CHANGE OF ITEM"
 530 PRINT"1)  CAPITAL EXPENDITURE",,"2)  WORKING CAPITAL "
 540 PRINT"3)  REVENUE",,,"4)  TAXATION"
 550 INPUT"▣ENTER COMMAND BY NUMBER (1-4)";K
 560 IFK<1ORK>4GOTO520
 570 INPUT"▣PERIOD NUMBER";L
 580 IFL>P-1THENPRINT"PERIOD NUMBER TOO HIGH":GOTO570
 590 INPUT"REVISED AMOUNT ";E
 600 IFK=1THENB(L)=E
 610 IFK=2THENP(L)=E
 620 IFK=3THENO(L)=E
 630 IFK=4THENR(L)=E
 640 PRINT"DO YOU WISH TO CHANGE ANY OTHER ITEM?"
 650 GETX$:IFX$<>"Y"ANDX$<>"N"GOTO650
 660 IFX$="Y"GOTO520
 670 GOTO230
 680 PRINT" P    CAP    REV    TAX    TOTAL  NPV  "
 690 FORX=0TOP-1
 700 PRINTXTAB(5)C(X)TAB(12)O(X)TAB(19)R(X)TAB(26)T(X);
 710 PRINTTAB(33)INT(V(X)+.5):NEXT
 720 PRINTTAB(5)C1TAB(12)O1TAB(19)R2TAB(26)T1TAB(33)INT((X1)+.5)
 730 PRINT"PRESS ANY KEY TO CONTINUE"
 740 GETX$:IFX$=""GOTO740
 750 GOTO350
 760 A$="9▣| ZZ ▣|":D$=" S99999 ▣|"
 770 A$=A$+D$+D$+D$+D$+D$+D$+D$
 780 FORX=1TO3:OPENX,4,X-1:NEXT:PRINT#3,A$
 790 B$="9▣|   "+MID$(A$,7,74)+"        ▣|"
 800 PRINT#1,"   PROJECT  - ";P$
 810 PRINT#1:PRINT#1,"   PERIOD IS ";12/A;"MONTHS":PRINT#1
 820 PRINT#1,"   NPV AT "R"% IS"INT(X1*100+.5)/100:PRINT#1
 830 PRINT#1," ┌────┬────────┬────────┬────────┬──────────";
 840 PRINT#1,"┬────────┬────────┬────────┐"
 850 PRINT#1," |    |        |WORKING |        ";
 860 PRINT#1,"|"TAB(8)"| CASH   |"TAB(8)"|  CUM   |"
 870 PRINT#1," |  P |CAPITAL |CAPITAL |REVENUE |TAXATION| FLOW   | ";
 880 PRINT#1,"  NPV   |  NPV   |":C$="┼────────":GOSUB930:T=0:FORX=0TOP-1
 890 N=INT(V(X)+.5):T=T+N:PRINT#2,0,X,B(X),P(X),O(X),R(X),T(X),N,T
 900 NEXT:GOSUB930:PRINT#3,B$:PRINT#2,0,B1,P1,O1,R2,T1,X1:C$="┴────────"
 910 PRINT#1," └────"C$C$C$C$C$C$C$"┘":PRINT#3,A$
 920 CLOSE1:CLOSE2:CLOSE3:GOTO350
 930 PRINT#1," ├────"C$C$C$C$C$C$C$"┤":RETURN
 940 END
READY.
```

A complete micro-based examination system

HAVING presented the programmed multiple-choice test as an educational tool for examination and revision purposes — December 1980 — I realised that it was possible to carry the idea to its logical conclusion and to program the complete cycle of events which comprises the multiple-choice system.

A complete system must have a comprehensive library of questions to be revised and updated when necessary. Each question is allocated a difficulty factor, DF, which is modified after each use of the question within a test. Thus, when questions are selected to form a test, their set of difficulty factors is used to guarantee the fairness of the test — to ensure that an average candidate will have, say, a pass mark of between 50 percent and 60 percent, if this is the required average mark bandwidth.

The complete system must start with the library, proceed with a selection of questions from the library and the make-up of a test paper, which can be checked and given to the candidates who sit the exam. Results can then be gathered and checked for fairness, and for anomalies, the accepted results can be fed back to the library and necessary amendments carried out.

From the start, teachers using the exams must be submitting useful questions to the library, while revising their own ideas through experience of the system, both in the marking/revising of questions, and in the writing of balanced papers. The library team are the scheme experts and offer advice and help in programming examination make-up and in marking results, as well as being responsible for revision of the library. They will also check and accept new questions, discarding questions which prove to be without merit.

by Rex Tingey

The examination room should have at least two microprocessor units coupled to a single floppy-disc unit and a printer, which will also be used by the library team and examining teachers when not used for tests. The Commodore Pet fills the bill exactly, say, six 16K 3001s, a 3022 printer and a 3040 dual-drive floppy-disc unit making the ideal set-up. All programming work is carried out to and from floppy discs in either program or sequential form.

The library consists of programs on disc which are re-written as sequential data. The question sets can then be read by an outline question-paper program from the floppy disc, and the data inserted into the program as a series of overlays, making up the complete paper, as selected by the examiner.

A test-paper program contains fundamentals to read data, present the exam to the candidate and to record his results in memory, retained after CLR or NEW. In memory, the results can be extracted by another program. The program reads and writes as sequential information to the floppy disc for later detailed analysis and correlation after all the candidates have finished the test. Then, the extracted results can be printed out and examined for anomalies and, if the difficulty factors seem wildly in error, the marks can be re-examined and possibly balanced toward the norm.

Amended results can be issued to the apprehensive candidates and returned to the library team for further analysis and for the updating of the library questions used for both content and DF. The library data program allows for this procedure, as well as the printout of complete or selected sets of answer/questions in a form similar to that screened for a test.

Difficulty factors are used to select a series of questions which can be expected to be answered by the average candidate in such a manner that he will achieve an average result. To this end, DFs are selected so that they can be plotted to approximate a Standard Deviation (Gaussian) Curve in distribution.

In our case, we have a base range, x axis, of 0 to 20, with every candidate correctly answering a question with a DF of 0, and none correctly answering one with a DF of 20. There is unlikely to be a question in data which a candidate will not, sooner or later, misunderstand, and up goes the DF from 0 to 1 or 2.

A DF of 20 usually means that there is something wrong with the question. New questions should enter the field with a pre-judged DF close to the median, and for a difficulty factor to rise to 20 means that it is never correctly answered. For this to happen could be due to one of four possibilities:

- Its source is obscure or from a high information level, beyond the scope of the course.
- The question is ambiguous.
- The "wrong" answer is correct.
- That part of the subject has not been taught.

The use of the question within the scheme will quickly root out any to which the last three apply, but it may take a few more passes through the system to conclude that the first is the reason for the high DF.

It is unlikely, anyway, that many questions will retain difficulty factors above 16 or 17 for long since post-exam inquests bring out sufficient information to pass answers to the difficult questions through the grape vine, which is one of the reasons why a good, growing library system is essential.

It can also be seen that the questions in the library can be for the lowest to the highest levels of examination, with a considerable overlap of difficulty factors.

The values selected for a particular paper need only an approximate Gaussian curve in distribution, particularly with only 25 questions to a paper. The ends will necessarily be clipped off the very high and very low factors. The factors given in the program listing are for example only, and should be re-started around the median. The last figures of the set should be zeroed.

Additional questions

The example library data program given is written for economics at about O level, but the data can, of course, be changed for 50 questions on any other subject, but following the same rules of entry. Further, the library need not be limited to 50 questions per subject, but additional question/answer sets require that all the relevant numbers in For/To sequences will need changing from either 50 or 350 to the new requirement. Note that there are seven data elements to each set.

Each complete data set contains one element which is multiple data — the sixth of each set — which keeps together the library number, the difficulty factor as a letter and the correct answer as a letter; A, B, C or D. The last element of the seventh group is a figure for the number of times the question has been used, to modify the difficulty factor, moving it to and from the mean.

In the Pet, the use of the Integer feature will always move the DF back, should the most recent figure be only one lower. Should the most recent figure be two or three higher, for a well-used question, the DF will not necessarily shift forward. Line 40050 may need adjustment mathematically if the DFs over-optimistically move backwards every run.

That can obviously be achieved by finding the difference between the complete value and the integer, adding 1 whenever it is above .5. Yet since any modifications are semi-manual, this can be kept in check by the library team.

The first five elements of a data set are the question and four answers — one answer and three distractors. The line numbers are made to correspond, in the manner shown, with the actual question numbers so that finding and entering data is simplified. The question can be up to 72 elements long, including spaces, as can the answer/distractor four; if longer, an error condition will prevail during subsequent extraction of this data.

Each library data program should have at its end the various sequences given here, to operate the data update, extraction, check-through, and sequential data write. The check-through program will operate to either the screen or to the printer, as selected, and the printer sequence will either print out all the data in proper order, or printout selected data only.

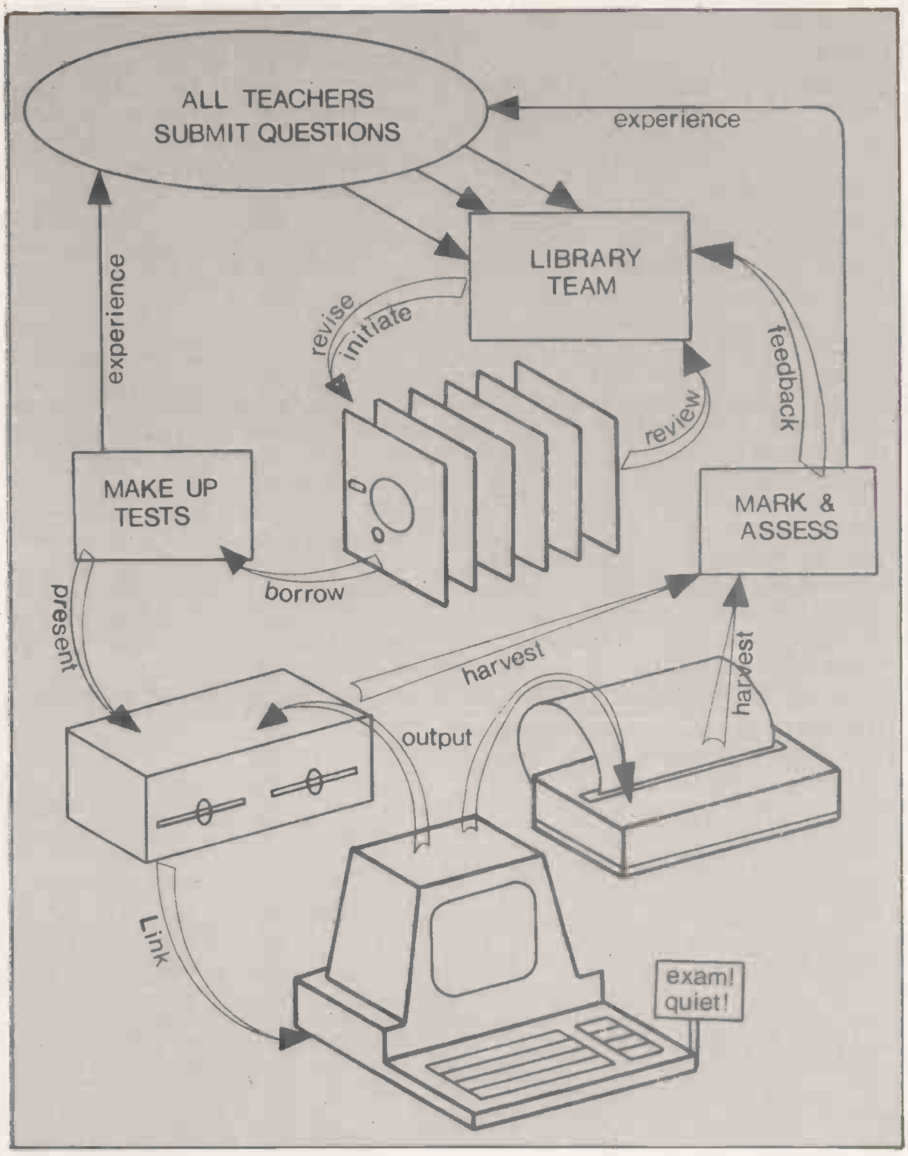
The first purpose of the multiple make-up program is to extract required data sets from the library, now existing as sequential data on the disc. This is achieved by line 0, and then 20000 on. Lines 60000-on are a mean of cancelling this first purpose part after it has completed its task.

Data extraction takes place by reading through the data, in sequence, until the required set is reached when it is screened complete with correct line numbers, "DATA", and the required five commas on each of three lines. It can then be checked, visually, to ensure that it is the required set, and returned over to place it into the data structure of the program now being formed.

Since this procedure clears variable and string memory automatically, it is necessary to Poke the progressing line numbers being created into a more substantial form. In this case, byte 1000 of the second cassette buffer is used. Further use is later made of this unused part of memory for results, candidate number and library numbers. There is no practical need for a second cassette recorder within the scheme.

Line numbers are made to match question set position × 10, so that the next two lines of data can be given +2, +2, and then the elementary number itself is incremented by one, giving up to 256 question numbers if required.

Note that this part of the scheme gives no limit, up to 256, to the number of question sets it is possible to overlay, but the number of read questions is limited in line 20010 to 50 library questions. As the library is expanded, this figure will need to be increased to match.



The multiple-choice examination system.

Standard form

The cursor is moved in conjunction with the print lines to be over the first line of data and to proceed downwards with the carriage returns to include the GOTO 20000. On the 25th question, however, the cursor should be shifted down to the lower-screened line which reads GOTO 60000. Returning over this produces a column of numbers, cancelling the now unwanted part of the program from useful memory.

The program now consists of the new data and all requirements to run, present and score the examination. Note that all inputs print three cursor-rights, a diamond, and three cursor-lefts. This produces on error a Re-do from start and a repeat Input request for all numerical inputs only, preventing a run failure and Ready.

However, string inputs will accept the diamond or other symbol and may abort because of this. The way to avoid this error is to follow the input with the line:
5052 IF N1$ = "◇ " GOTO 5050

This is not necessary here as the string is used only in the final score routine. Save the completed test paper to the floppy disc.

The examination is presented in a standard form, but with the questions appearing in a random order which is decided by the initial shuffle of 25 figure pairs. If the test contains more than 25 questions, the figure-pair string will have to be concatenated with the extra numbers required, and the figures on lines 5100 and 5200 will need amending, and the score section will need to be altered to suit the percentage requirement.

As the questions are answered, they score four marks each for a correct response and zero for an incorrect response. The correct answer must still be sought and given or the test will not proceed; further marks cannot be lost or gained on that particular question.

There is no reason why a candidate should not be informed of a correct answer after failing to know it during the test. Line 6060 could be modified to print the correct response. Seeing the correct response after making the error is good revision work.

As each question is answered, a byte in the second cassette buffer corresponding to the question number is Poked with the score, 4 or 0, so that at a later stage a For-To loop can collect scores in a correct sequence of question position. At the same time the value of Q$ is extracted with the same order and Poked some 50 bytes up from that group, forming another series.

Score reviewed

At the end of the test, a score is displayed, however the candidate should be informed that the score is open to review, and that his result could be subject to alteration, dependent on overall results.

The harvest results program is for the invigilator to go to each computer in the examination room in turn and to load this program into memory and select whichever method of data transfer is required to access the results from the second cassette buffer area.

Results can be printed to the screen, printed out on the printer, both with

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similar-columned format using the candidate number as a heading: or the information can be directed to be written to the disc as sequential information. Further, a list of the relationship of examination question to library question can be printed out.

Writing to the disc is the most important function. Each file requires correct opening processes with no short cuts in this case. Some are possible using string inserts but these tend to be unreliable. Each file must also be closed correctly otherwise the data will not be accessible from the disc afterwards. Only nine results are programmed; this will obviously need increasing if there are more candidates.

If the only part of this program required is writing to disc area, which transfers results automatically to disc when the test is complete, then that part of the program can be written directly into the make-up program, and the harvest results will not be needed.

The only problem might be that of the wrong candidate number being written in, causing much confusion. However, the invigilator could make a point of checking that number, and if a mistake has been made then the sequence could be scratched, and the harvest results loaded for the sequence to be re-entered with the correct candidate number.

Assess difficulty factor is a program to read the results from floppy disc when requested from the keyboard, and to printout finally a full list of present difficulty factor against question number with corresponding library number in brackets. When entering various candidates' exam numbers, those numbers already extracted are printed across the screen and incremented so that double extractions can be avoided.

Files are correctly opened and closed to printer and to floppy-disc unit so that no errors result. Variables are correctly dimensioned. These must be increased for longer test papers. More files must be opened if more candidates than nine are tested.

A particular and peculiar phenomenon is that when a set of word data is written in sequential form to a floppy disc, the second and each subsequent word has a space on the front end when read back as a string variable. Thus if A$ = "READ", then LEN(A$) will be four for the first word read but five for that same word if it is second or subsequent.

However, if the set contains number data then a single number, here four, emerges with a LEN of three. So if VAL(A$) is requested, the answer is always 0. Note that the program takes the easy way out and takes the back two to leave the front end open for the VAL reading.

If multiple-choice examinations were more widely accepted throughout the country, the methods outlined here could be adopted for GCE and CSE examinations — for the written parts, at least. A country-wide candidate-numbering system would be required, with centrally-despatched floppy discs, to be returned for computerised marking and cross-checking, with printout of results available by return of post.

Listing 1. Economics multiple-choice library.

```
10 DATAECONOMICS DEPENDS UPON,SCARCITIES,MONEY FLOW,MARKETS,TRADING,1BA,1
20 DATAV.A.T. FIRST LEVIED IN U.K. IN,1966,1969,1971,1973,2RD,5
30 DATASAVING & INVESTMENT THEORY PUT FORWARD  BY,ORWELL,GEDDES,KEYNES
32 DATAMALTHUS,3KC,2
40 DATANATIONAL INCOME FIGURE INCLUDES AS TRANS-FER PAYMENTS
42 DATASALARIES,INTEREST,PENSIONS,WAGES,4NC,0
50 DATAWHICH IS NOT A FACTOR OF PRODUCTION
52 DATATRANSPORT,CAPITAL,LABOUR,LAND,5GA,6
60 DATAWHICH IS 'INFERIOR GOOD',WINE,BUTTER,MARGARINE,SALMON,6EC,4
70 DATAWHICH IS 'CONSPICUOUS CONSUMPTION' GOOD
72 DATASUGAR,GOLD WATCH,CIDER,ICE CREAM,7FB,3
80 DATAWHICH OF THESE IS NOT INVOLVED WITH      ISSUING NEW SECURITIES
82 DATASTOCK EXCHANGE,ISSUING HOUSES,FINANCE CORPORATION,INVESTMENT TRUST
84 DATA8JA,4
90 DATAWHICH HELPS TO LOWER PRICES
92 DATAINFLATION,REFLATION,DEFLATION,HYPER-INFLATION,9DC,6
100 DATAWHICH IS NOT A PUBLIC CORPORATION
102 DATAPOST OFFICE,B.B.C,I.C.I.,BRITISH AIRWAYS,10CC,2
110 DATATRADING BY THE EXCHANGE OF GOODS IS
112 DATARETAILING,REGRATING,BARTERING,CHANDLING,11HC,5
120 DATAECONOMIC 'WEALTH' MEANS,GOLD,REVENUE,INCOME,GOODS,12GD,7
130 DATAWHICH IS CONSIDERED' SOCIAL CAPITAL'
132 DATAFARMLAND,RAILWAYS,SHOPS,FACTORIES,13FB,6
140 DATAIN 1800'S FUTURE POPULATION EXPLOSION   FORECAST BY
142 DATARICARDO,SMITH,GILBERT,MALTHUS,14HD,2
150 DATAECONOMY OF GREAT BRITAIN IS
152 DATAFREE ENTERPRISE,SOCIALIST,MIXED,PLANNED,15NC,4
160 DATATHE DIRECT TAX IS,VAT,SURTAX,CAR LICENCE,CUSTOMS DUTY,16MB,3
170 DATATHE INDIRECT TAX IS,EXCISE DUTY,INCOME TAX,ESTATE DUTY,LOCAL RATES
172 DATA17KA,4
180 DATAFORECAST OF UK POPULATION IN 1998 APPROX
182 DATA54 MILLION,60 MILLION,42 MILLION,56 MILLION,18JB,2
190 DATASERVICE INDUSTRIES ARE KNOWN AS
192 DATAGROWTH SECTOR,PRIMARY SECTOR,SECONDARY SECTOR,TERTIARY SECTOR,19GD,3
200 DATA% CHANGE IN DEMAND / % CHANGE IN PRICE  REPRESENTS ELASTICITY
202 DATAOF DEMAND,OF PRICE,OF SUPPLY,OF UTILITY,20HA,6
210 DATABUTTER & MILK FROM SAME SOURCE KNOWN AS
212 DATAELASTIC DEMAND,JOINT DEMAND,COMPOSITE SUPPLY,JOINT SUPPLY,21DD,4
220 DATAEEC INITIATED IN,1960,1956,1959,1957,22OD,3
230 DATAFIRMS RAISE NEW CAPITAL FROM
232 DATABANK OF ENGLAND,INVESTMENT TRUSTS,CAPITAL MARKET,STOCK EXCHANGE,23IC
234 DATA6
240 DATAUK JOINED THE EEC IN,1973,1970,1969,1971,24PA,2
250 DATAUNEMPLOYMENT CAUSED BY TECHNICAL         IMPROVEMENT IS
252 DATASTRUCTURAL,FRICTIONAL,CYCLICAL,RESIDUAL,25NB,7
260 DATAIN 1694 THE BANK OF ENGLAND WAS FOUNDED BY
262 DATASPENCER,PAINE,PATERSON,HAMPDEN,26EC,3
270 DATAAN EXAMPLE OF VERTICAL & HORIZONTAL      COMBINATION IS
272 DATAHOLDING COMPANY,CO-OP SOCIETY,PRIVATE LTD COMPANY,LIMITED LIABILITY CO
274 DATA27LA,5
280 DATAMARKET CONSISTING OF MANY SMALL FIRMS IS
282 DATAMONOPOLY,OLIGOPOLY,OLIGOMERATE,OLIGOPSONY,28KB,7
290 DATASTOCKBROKER MAKES HIS PROFIT BY
292 DATABUYING,SELLING,BOTH A & B,COMMISSION,29LD,4
300 DATAAIM OF MONOPOLIST IS TO
302 DATAMINIMISE LOSSES,RAISE PRICES,INCREASE PRICES,MAXIMIZE PROFITS,30ID,7
310 DATAREGION OF HIGHEST UNEMPLOYMENT
312 DATANORTHERN IRELAND,SCOTLAND,WALES,LONDON,31GA,8
320 DATAIN 1844 FIRST MAJOR CO-OP SOCIETY FORMEDIN
322 DATAMANCHESTER,ROCHDALE,LONDON,NEW LANARK,32EB,3
330 DATAPROPORTION OF RETAIL TRADE BY CO-OP SOC.APPROX,12%,9%,15%,6%,33MA,5
340 DATAEXAMPLE OF AN ENTREPRENEUR IS
342 DATABEECHING,LLOYD GEORGE,NUFFIELD,RICARDO,34FC,8
350 DATAC.B.I. FORMED IN,1965,1952,1958,1968,35QA,5
360 DATA1966- FIRST CORPORATION TAX WAS,20%,26%,40%,45%,36IC,2
370 DATA1926 GENERAL STRIKE STARTED IN,JANUARY,MAY,AUGUST,MARCH,37RB,6
380 DATACO-ORDINATOR OF FACTORS OF PRODUCTION IS
382 DATACHAIRMAN,MANAGER,DIRECTOR,ENTREPRENEUR,38HD,5
390 DATACOMMERCIAL BANKS RESERVE RATIO IS,15%,10%,12.5%,18%,39KC,4
400 DATAWHICH IS THE MERCHANT BANK?
402 DATAROTHSCHILDS,NATIONAL GIRO,CO-OP. BANK,BANK OF ENGLAND,40FA,4
410 DATAP.A.Y.E. IS A FORM OF,VAT,INCOME TAX,EXCISE DUTY,PURCHASE TAX,41JB,2
420 DATAEXAMPLE OF GOVERNMENT CREATED MONOPOLY
422 DATAPOST OFFICE,STOCK EXCHANGE,BUILDING SOCIETIES,TOURIST BOARD,42JA,5
430 DATAAN ADVANTAGE OF HORIZONTAL COMBINATION  IS
432 DATAINVENTIONS AIDED,PRICES FIXED,PRICES STABILIZED,SELLER CONTROL,43EC
434 DATA6
440 DATAFINAL CUSTOMS CLEARANCE GIVEN BY
442 DATABILL OF ENTRY,BILL OF LADING,BILL OF EXCHANGE,CERTIFICATE OF TRADE
444 DATA44PA,2
450 DATAINVESTOR SELLING SHARES IN FALLING      MARKET IS
452 DATAEAGLE,BEAR,STAG,BULL,45CB,7
460 DATAINTEREST PAYED ON PREMIUM BONDS IS,5%,3%,4%,NIL,46GD,6
470 DATAFINANCE HOUSES PROVIDE FOR
472 DATASTOCK BUYERS,HOUSE BUYERS,HIRE-PURCHASE,BANK LOANS,47HC,5
480 DATAA CLEARING HOUSE DEALS WITH
482 DATASTOCKS,CHEQUES,SHARES,LABOUR,48IB,3
490 DATAGROUP OF FIRMS SELLING PRODUCTS THROUGH CENTRAL AGENCY-
492 DATAMONOPOLY,OLIGOPOLY,WHOLESALER,CARTEL,49LD,7
500 DATABUYING MORE AT LOWER PRICE IS FACTOR OF
502 DATAUTILITY,SCARCITY,DEMAND,CHOICE,50NA,8
10000 PRINT"J ECONOMICS MULTIPLE QUESTIONS":PRINTTAB(6)"SELECT OPERATION
10010 PRINT"FOR DATA RUN-THROUGH 'A'":PRINT"FOR PRINT-OUT OF QUESTIONS  B'
10020 PRINT"TO UP-DATE DATA PRESS 'C'":PRINT"TO WRITE DATA TO DISK 1  D'"
10030 PRINT"TO READ DATA FROM DISK 'E'
10040 PRINT"PRESS 'Z' IF TASK COMPLETE!
10100 GETZ$:IFZ$=""GOTO10100
10150 IFZ$="Z"THENEND
10160 IFZ$>"E"THENGOTO10040
10000 PRINT"J ECONOMICS MULTIPLE QUESTIONS":PRINTTAB(6)"SELECT OPERATION
10010 PRINT"FOR DATA RUN-THROUGH 'A'":PRINT"FOR PRINT-OUT OF QUESTIONS 'B'
10020 PRINT"TO UP-DATE DATA PRESS 'C'":PRINT"TO WRITE DATA TO DISK 1:'D'"
10030 PRINT"TO READ DATA FROM DISK 'E'
10040 PRINT"PRESS 'Z' IF TASK COMPLETE!
10100 GETZ$:IFZ$=""GOTO10100
10150 IFZ$="Z"THENEND
10160 IFZ$>"E"THENGOTO10040
10170 IFZ$="A"GOTO60000
10180 IFZ$="B"GOTO30000
10190 IFZ$="C"GOTO40000
10200 IFZ$="D"GOTO50000
20000 OPEN2,8,2,"1:DATA,S,R"
20010 FORA=1TO350:INPUT#2,A$:PRINTA$:NEXT:CLOSE2
29999 END
30000 PRINT"J ECONOMICS QUESTIONS PRINT-OUT":OPEN4,4:GOSUB39000
30010 INPUT"LETTER FOR ALL, OR NUMBER FOR ONE";Z$:V=VAL(Z$):IFV>0GOTO30100
30020 FORA=1TO50:READA$,B$,C$,D$,E$,F$,G:GOSUB38000:PRINT#4:PRINT#4:NEXT
30050 CLOSE4:GOTO10000
30100 RESTORE:FORA=1TO50:READA$,B$,C$,D$,E$,F$,G:IFA=VGOTO30200
30110 NEXT
30200 GOSUB38000:PRINT"PRESS'Z'IF FINISHED, OR NUMBER FOR MORE
30210 GETZ$:IFZ$=""GOTO30210
30220 V=VAL(Z$):IFZ$="Z"THENCLOSE4:END
30230 IFV>0THEN30010
37999 END
38000 PRINT#4,A$:PRINT#4:PRINT#4,"A   "B$:PRINT#4,"B   "C$:PRINT#4,"C   "D$
38010 PRINT#4,"D   "E$:PRINT#4:PRINT#4,F$,,G:PRINT#4:PRINT#4:RETURN
39000 PRINT#4,CHR$(1)" ECONOMICS  QUESTION DATA":PRINT#4:RETURN
39999 END
40000 INPUT"J AMEND QUESTION NUMBER ",Q:RESTORE
40010 FORA=1TO50:READA$,B$,C$,D$,E$,F$,G:IFA=QGOTO40030
40020 NEXT
40030 G$=RIGHT$(F$,2):F=ASC(G$):F=F-64:G1$=LEFT$(G$,1)
40040 PRINT"OLD DIFFICULTY FACTOR "F"("G1$")
40050 INPUT"ENTER FOUND D.F.";R:G9=G+1:F9=F*G:F8=F9+R:F7=INT(F8/G9)
40060 G2=F7+64:G2$=CHR$(G2):PRINT" NEW  D.F. "F7 "("G2$")  & ADD 1 TO LAST.
40090 POKE216,25:PRINTTAB(1);"GOTO40000"
40100 PRINT" PRESS RETURN ":PRINT"LIST"Q"-"Q"":GOTO40200
49999 END
50000 OPEN15,8,15:PRINT#15,"I1":CR$=CHR$(13):OPEN2,8,2,"1:DATA,S,W"
50010 FORI=1TO350:READA$
50020 PRINT#2,A$CR$
50030 NEXT
50040 CLOSE2:CLOSE15
59999 END
60000 FORA=1TO50:READA$,B$,C$,D$,E$,F$,G:TI$="000000"
60010 PRINT"J RUN THROUGH QUESTIONS ":V=VAL(F$)
60020 PRINT"QUESTION NUMBER "A"
60030 PRINTA$"":PRINT"A   "B$:PRINT"B   "C$:PRINT"C   "D$:PRINT"D   "E$
60040 PRINT""F$,G
60050 IFTI$<"000006"GOTO60050
60100 NEXT
READY.
```

Listing 2. Multiple make-up program.

```
0 POKE1000,1:GOTO20000
4800 GOSUB8000:PRINTTAB(4)"ANSWER WITH KEY  A, B, C, OR D
5000 C$="01020304050607080910111213141516171819202122232425":R=RND(0):O=-1
5010 R=2*INT(LEN(C$)*RND(1)/2+1)-1:N$=MID$(C$,R,2)
5020 IFR>1THENT$=LEFT$(C$,R-1):GOTO5040
5030 T$="":REM ********* COPYRIGHT (C) REX L TINGEY ******* 1981
5040 C$=T$+MID$(C$,R+2):D$=D$+(N$):IFLEN(C$)>=1THEN5010
5050 INPUT"     ENTER SURNAME";N1$
5060 INPUT"     CANDIDATE NUMBER";N:POKE900,N
5100 GOSUB8000:O=O+2:O$=MID$(D$,O,2):A=VAL(O$):IFO>50GOTO9000
5200 RESTORE:FORB=1TO25:READL$,M$,N$,O$,P$,Q$,R:IFB=AGOTO6000
5210 NEXT
6000 PRINT""L$"":PRINTTAB(6)"A   "M$"":PRINTTAB(6)"B   "N$""
6010 PRINTTAB(6)"C   "O$"":PRINTTAB(6)"D   "P$"":K=4
```

```
6020 GETZ$:IFZ$=""GOTO6020
6030 IFZ$>"D"GOTO6020
6040 IFZ$<"A"GOTO6020
6050 Y$=RIGHT$(Q$,1):IFZ$=Y$GOTO7000
6060 PRINTZ$" IS INCORRECT":K=0:GOTO6020
7000 I=I+K:J=J+1:PRINT"CORRECT"SPC(1)Y$SPC(14)J" SCORE"I:TI$="000000"
7020 K1=900+A:POKEK1,K:V1=VAL(Q$):K2=949+A:POKEK2,V1
7040 IFTI$<"000003"GOTO7040
7050 GOTO5100
7999 END
8000 PRINT" ECONOMICS  MULTIPLE CHOICE":RETURN
9000 GOSUB8000
9010 PRINT"CANDIDATE "N1$" SCORES":PRINTTAB(15)I"%
19999 END
20000 PRINT"ADDING QUESTIONS FROM DATA":I$="DATA":J$=",":P1=PEEK(1000)
20008 PRINT"QUESTION NUMBER "P1
20010 INPUT"ENTER DATA NUMBER";X:OPEN2,8,2,"1:DATA,S,R":FORA1=1TO50
20030 FORA=1TO7:INPUT#2,A$:A$(A)=A$:NEXT:IFA1=XGOTO20100
20040 NEXTA1
20100 P=P1*10:PRINT""P;I$A$(1):P=P+2:PRINTP;I$A$(2)J$A$(3)J$A$(4)J$A$(5)
20110 P=P+2:PRINTP:I$A$(6)J$A$(7):P1=P1+1:POKE1000,P1:CLOSE2:PRINT"GOTO20000
20120 PRINT"GOTO60000:REM*RETURN OVER AT ENDRETURN OVER DATA
29999 END
60000 PRINT"20000200082001020030 20040
60010 PRINT"2010020110201206000060010
60020 PRINT"HOME CURSOR & RETURN OVER!
READY.
```

Listing 3. Harvest results program.

```
1 REM COPYRIGHT (C) REX L TINGEY * 1981
10 DIMA(26)
100 FORA=0TO25:B=900+A:C=PEEK(B):Z=A:A(Z)=C:NEXT:A=0
110 FORZ=1TO25:A=A+A(Z):NEXT:B=A
200 PRINT"EXAMINATION RESULTS
300 PRINT"SELECT PRESENTATION MODE
320 PRINT"PRESS 'A' FOR SCREEN RESULTS.
340 PRINT"PRESS 'Z' FOR PRINT-OUT
350 PRINT"PRESS 'Q' FOR DATA TRANSFER TO DISK
360 PRINT"FOR LIST OF LIBRARY QUESTION NUMBERS
800 GETZ$:IFZ$=""GOTO800
810 IFZ$="Z"GOTO2000
820 IFZ$="Q"GOTO3000
830 IFZ$="P"GOTO4000
1010 PRINT"CANDIDATE NUMBER "A(0)" SCORE "B
1020 PRINT"1-"A(1),"2-"A(2),"3-"A(3),"4-"A(4)
1030 PRINT"5-"A(5),"6-"A(6),"7-"A(7),"8-"A(8)
1040 PRINT"9-"A(9),"10-"A(10),"11-"A(11),"12-"A(12)
1050 PRINT"13-"A(13),"14-"A(14),"15-"A(15),"16-"A(16)
1060 PRINT"17-"A(17),"18-"A(18),"19-"A(19),"20-"A(20)
1070 PRINT"21-"A(21),"22-"A(22),"23-"A(23),"24-"A(24),"25-"A(25)
1080 PRINT"PRESS Z TO CLOSE: OTHER TO RE-RUN.
1100 GETZ$:IFZ$=""GOTO1100
1110 IFZ$="Z"THENEND
1120 RUN
2000 OPEN4,4:PRINT#4:PRINT#4,"CANDIDATE NUMBER "A(0)" SCORE "B
2010 PRINT#4:PRINT#4
2020 PRINT#4,"1-"A(1)," 2-"A(2)," 3-"A(3)," 4-"A(4)," 5-"A(5)
2030 PRINT#4:PRINT#4,"6-"A(6)," 7-"A(7)," 8-"A(8)," 9-"A(9)," 10-"A(10)
2040 PRINT#4:PRINT#4,"11-"A(11),"12-"A(12),"13-"A(13),"14-"A(14),"15-"A(15)
2060 PRINT#4:PRINT#4,"16-"A(16),"17-"A(17),"18-"A(18),"19-"A(19),"20-"A(20)
2070 PRINT#4:PRINT#4,"21-"A(21),"22-"A(22),"23-"A(23),"24-"A(24),"25-"A(25)
2080 PRINT#4:CLOSE4:PRINT" TO CLOSE: OTHER TO RE-RUN
2100 GETZ$:IFZ$=""GOTO2100
2110 IFZ$="Z"THENEND
2120 RUN
3000 PRINT"TRANSFER RESULTS TO DISK"
3010 PRINT"REMEMBER ONLY NINE AT PRESENT!"
3020 INPUT"ENTER CANDIDATE'S NUMBER";C
3100 OPEN15,8,15:PRINT#15,"I1":CR$=CHR$(13)
3110 IFC=1THENOPEN2,8,2,"1:1,S,W"
3112 IFC=2THENOPEN2,8,2,"1:2,S,W"
3113 IFC=3THENOPEN2,8,2,"1:3,S,W"
3114 IFC=4THENOPEN2,8,2,"1:4,S,W"
3115 IFC=5THENOPEN2,8,2,"1:5,S,W"
3116 IFC=6THENOPEN2,8,2,"1:6,S,W"
3117 IFC=7THENOPEN2,8,2,"1:7,S,W"
3118 IFC=8THENOPEN2,8,2,"1:8,S,W"
3119 IFC=9THENOPEN2,8,2,"1:9,S,W"
3200 FORZ=0TO25:PRINT#2,A(Z)CR$:NEXT:CLOSE2:CLOSE15
3300 PRINT" TO CLOSE: OTHER TO RE-RUN
3310 GETZ$:IFZ$=""GOTO3310
3320 IFZ$="Z"THENEND
3330 RUN
4000 OPEN4,4:PRINT#4:PRINT#4,CHR$(1)" ECONOMICS "
4020 FORA=1TO25:B=949+A:C=PEEK(B):PRINT#4,A" = "C:NEXT:PRINT#4:CLOSE4
4300 PRINT" TO CLOSE: OTHER TO RE-RUN
4310 GETZ$:IFZ$=""GOTO4310
4320 IFZ$="Z"THENEND
4330 RUN
READY.
```

Listing 4. Assess difficulty factor.

```
10 DIMA(25):DIMR(25):DIMB(25):DIMC(25):DIMD(25):DIME(25):DIMF(25):DIMG(25)
20 DIMH(25):DIMI(25):DIMS(25)
100 GOSUB60000:IFN=0THENGOSUB50020
110 IFN>0THENPRINT"NUMBERS ENTERED":GOSUB50000
200 N=N+1:IFN>9THENPRINT"THATS ALL":GOTO10000
210 INPUT"CANDIDATE NUMBER (Z IF ALL)";Z$(N)
220 IFZ$(N)="Z"THENN=N-1:GOTO10000
230 IFZ$(N)="*"GOTO210
240 A=VAL(Z$(N))
800 IFA=1GOTO1000
810 IFA=2GOTO2000
820 IFA=3GOTO3000
830 IFA=4GOTO4000
840 IFA=5GOTO5000
850 IFA=6GOTO6000
860 IFA=7GOTO7000
870 IFA=8GOTO8000
880 IFA=9GOTO9000
1000 OPEN2,8,2,"1:1,S,R"
1010 FORB=0TO25:INPUT#2,B$:C$=RIGHT$(B$,2):A(B)=VAL(C$):NEXT:CLOSE2:GOTO100
2000 OPEN2,8,2,"1:2,S,R"
2010 FORB=0TO25:INPUT#2,B$:C$=RIGHT$(B$,2):B(B)=VAL(C$):NEXT:CLOSE2:GOTO100
3000 OPEN2,8,2,"1:3,S,R"
3010 FORB=0TO25:INPUT#2,B$:C$=RIGHT$(B$,2):C(B)=VAL(C$):NEXT:CLOSE2:GOTO100
4000 OPEN2,8,2,"1:4,S,R"
4010 FORB=0TO25:INPUT#2,B$:C$=RIGHT$(B$,2):D(B)=VAL(C$):NEXT:CLOSE2:GOTO100
5000 OPEN2,8,2,"1:5,S,R"
5010 FORB=0TO25:INPUT#2,B$:C$=RIGHT$(B$,2):E(B)=VAL(C$):NEXT:CLOSE2:GOTO100
6000 OPEN2,8,2,"1:6,S,R"
6010 FORB=0TO25:INPUT#2,B$:C$=RIGHT$(B$,2):F(B)=VAL(C$):NEXT:CLOSE2:GOTO100
7000 OPEN2,8,2,"1:7,S,R"
7010 FORB=0TO25:INPUT#2,B$:C$=RIGHT$(B$,2):G(B)=VAL(C$):NEXT:CLOSE2:GOTO100
8000 OPEN2,8,2,"1:8,S,R"
8010 FORB=0TO25:INPUT#2,B$:C$=RIGHT$(B$,2):H(B)=VAL(C$):NEXT:CLOSE2:GOTO100
9000 OPEN2,8,2,"1:9,S,R"
9010 FORB=0TO25:INPUT#2,B$:C$=RIGHT$(B$,2):I(B)=VAL(C$):NEXT:CLOSE2:GOTO100
10000 OPEN4,4:PRINT#4:PRINT#4,CHR$(1)"DIFF. FACTORS"
10080 FORA=1TO25:R(A)=(A(A)+B(A)+C(A)+D(A)+E(A)+F(A)+G(A)+H(A)+I(A))/N
10100 S(A)=INT(R(A)*5):R(A)=20-S(A):B=949+A:C=PEEK(B)
10200 PRINT#4,A"="R(A),"("C")":NEXT
49999 CLOSE4:END
50000 PRINTZ$(1)" "Z$(2)" ";Z$(3)" ";Z$(4)" "
50010 PRINT"TAB(8)Z$(5)" ";Z$(6)" ";Z$(7)" ";Z$(8)" ";Z$(9)
50020 PRINT"":RETURN
60000 PRINT"ASSESSMENT OF D.F.":RETURN
READY.
```

Simulating 350K of virtual memory capacity

THE FULL 340K of the Pet disc memory and the 32K of main memory can be used with the appearance of being virtually continuous. Thus a database of some 350K is possible giving a facility normally available only on much larger machines. The method I describe to obtain this has been written with the Pet in mind but, it is readily transferable to other systems.

The term virtual memory was one made much of by IBM during its launch of the facility some years ago but as I said in my article on co-ordinate drilling in the

by J A Forbes

February 1981 issue, there is not much that is new, and, indeed, the facility of virtual memory and its concept first appeared in this country when computing was in its infancy. I believe that in fact it was the Argus range of computers.

Many articles have been written on how, by judicious use of Poke, one can preserve the variables from another program. However, this has the problem that such arrangements are normally valid only for one specific set of circumstances. What this means is that if any of the characters are changed, the linking arrangement must also be changed.

As an introduction to the subject, I would refer you to Nick Hampshire's book *The Pet Revealed* and in particular to pages 68 to 73 where the method and structure of linking Basic lines is discussed. In particular, page 71 gives a line-find routine which will print out the link address contents of a given line while page 72 shows how this information may be used to link programs together.

Let us first examine overlay/main subroutine-linking arrangements. In the Pet, line numbers and the location of program lines and their contents are organised as follows.

The user program starts from memory location 1024 and upwards. The first two bytes of a program line contain the address of the next program line — the link address. The third and fourth bytes contain the user line number in binary format and the remaining bytes are the program line contents up to the address of the next line. The end of a statement is indicated by a zero byte. This can be shown diagrammatically as in figure 1.

The first two bytes of the last line give the address of a location which contains two zeros which is used to indicate the end of the program.

When a program is loaded using a load command contained in a program already in the computer memory, the new pro-

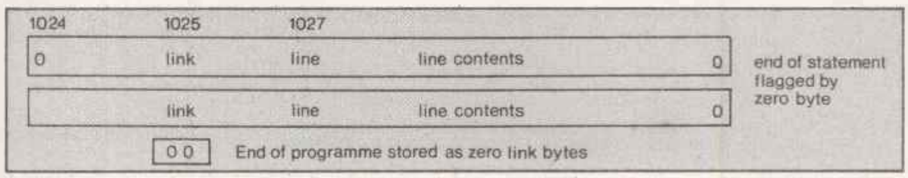


Figure 1.

gram will be loaded from memory location 1024 upwards, as described. Clearly, the new program will overwrite an area of memory equal to its own length. To overcome this problem when loading the various overlay programs, we must ensure that the main program loaded occupies an area of memory greatly exceeding that of any subsequent program and that the parts of the original program which we wish to leave undisturbed have line numbers greater than those used in any subsequent overlay. We must also ensure that a means exists for linking the end of the new program to the beginning of the undisturbed portion of the original program.

This may be more clearly illustrated diagrammatically by figure 2.

From this consideration of how lines are held in memory and how a main program would have to be constructed to allow overlays, let us now look at a typical main-core program which has the following features:

- A menu of selectable overlays each of which can be up to, say, 10K long.
- A set of standard utilities which are called by each overlay.

It is also necessary to determine at the start what other programs you may wish the main program to call into memory. For example, a reverse-field facility may be required which can be used by either the main program or the overlays and which can reverse field lines, blocks or even lines in sequence. This program is written in Hex and located in the cassette 1 buffer and is called Reverse. The listing given here may be entered into memory by the machine-code monitor, then saved and recalled by the main program when it is first run.

To use this program it is necessary to provide it with some basic information prior to calling it during a program. The following Pokes are required

POKE 714,	Number of columns in from edge of screen.
POKE 715,	128
POKE 716,	Screen line number of start — 1 to 25 from top of screen.
POKE 717,	Number of lines in the block.
POKE 718,	Number of columns in block.

```
0282 98 48 18 A9 28 65 01 EA
028A 85 01 EA A9 00 65 02 EA
0292 85 02 EA 68 A8 60 48 98
029A 48 8A 48 AE 7C 02 20 82
02A2 02 CA D0 FA AE 7D 02 AC
02AA 7E 02 B1 01 49 80 91 01
02B2 88 D0 F7 CA F0 06 20 82
02BA 02 4C A9 02 68 AA 68 A8
02C2 68 60 00 00 00 00 00 00
02CA 00 00 00 00 00 00 00 00
02D2 AD CA 02 85 01 AD CB 02
02DA 85 02 EA AD CC 02 8D 7C
02E2 02 AD CD 02 8D 7D 02 AD
02EA CE 02 8D 7E 02 4C 98 02
```

This reverse-field function can be called by a SYS (722) command preceded by the necessary Pokes. An example of its use is in alternately flashing the words letter and number in the option legend which appears at the bottom of each displayed overlay page. See subroutine at line 40000 in the main program listing.

The calling line for this and any other utilities must be entered as the very first lines in the main-core program. This will ensure that they are loaded when the main program is first run but, of course, these lines will be later destroyed as they are overwritten by the first overlay called.

Next the filler area is entered up to the point where the filler has occupied an area of memory slightly greater than the maximum size of the largest overlay. In my case I used an area occupying 10K. One can calculate in Hex what the equivalent decimal value is of the filler area required and, when keying in the filler, periodically examine memory.

Memory check

For example, 10K = 2710 in Hex, therefore, when the entered filler reaches 2710 you know that there will be an area of 10K for overlays. The filler area can be filled in by simply entering sequential print statements and typing in anything at all. One method is to load any old 10K program, re-number it using a re-number program and then enter the initial call lines previously mentioned.

It is essential to use low line-number values, and increments, so that high values are preserved for the main program, e.g., make a rule that line numbers from 1 to 1900 are reserved for overlays or filler and line numbers of 20000 upwards for the main program.

Having generated a filler area, it now

remains to complete the main program. The exact format will depend on the application but will probably comprise a menu page which branches on selection to display the first page of the selected overlay and, while this page is being read by the user, the remaining pages are being loaded into the filler area, transparently to the user.

The next requirement would probably be a means of allowing users to progress through the overlay pages at their own reading rate and, therefore, a legend-generating subroutine is incorporated into the main program which, when called by the overlay, will print "PRESS ANY LETTER TO CONTINUE" and "PRESS ANY NUMBER FOR MENU".

In addition, there is a timer incorporated into the subroutine which will return the display to the menu if no key has been depressed for 40 seconds.

The fact that the timer is entered by a Gosub from an overlay but exited by a branch to menu would normally result ultimately in an out-of-memory error as the stack eventually overflows. However Basic performs a Run after each selection and this re-initialises the stack after each menu selection.

A sample program listing is given for both main and overlay programs. While this is only a demonstration program, it will work and should be loaded and run to develop a feel for the system. Only one overlay is given to show the principle.

The main program shows the utility calling lines at lines 2 and 3; the filler area at lines 2110 to 2250; the menu at lines 20000 to 20640; two overlay first pages — the others indicated in the menu are implied but not shown; the timer and key depression check at lines 40000 to 40030 — note the Poke and SYS (722); commands which use the Reverse program to reverse field the words Letter and Number; and finally the legend subroutine at lines 41000 to 41010.

The overlay listing shows the SYS(29808) command which alters the link address for line 18000 to that of line 20000 in the main program. The Gosub at line 10 and 20 print the legend on line 24 and 25 after the overlay has been loaded from disc. Note that the last line before line 18000 returned you to the menu indicating that the last page has been viewed but there is no reason why one could not offer a choice of either the menu or that overlay's first page at line 25500.

Having created both the overlay and main program, it is now time to examine the method of linking the two. Since this linking program is of general interest, the assembly listing is given in full. First let us consider the method given in *The Pet Revealed*. The problem with that method is the linking commands apply not to a line number value but rather to the location of that line in the overlay when in memory. What this means is that should you change the number of characters before the last line, the link arrangements are no longer valid and have to be re-calculated.

Link address

What is required is a means of finding and changing the link address of a given line number value regardless of its position in memory. A short assembly-language program called Link has been prepared which is loaded by the main program during its initial run and stored in a protected area at top of memory. The reason that it sits some 2K down is to allow for insertion of other utlities such as a soft Toolkit, etc.

When the overlay in question is loaded, line 5 will cause Link to search through memory until it finds line 18000 and then change its link address to that of line 20000 in the main program. It is fast and effective provided that the last line is always 18000 and that the filler area or any other line prior to line 20000 in the main program is not altered in quantity since that would move the location of line 20000.

The value of the line which Link is seeking may be changed just as the link address to which it will link that line, may also be changed. The values incorporated in the listing are obviously those for this demonstration but may be changed by Poking new values or changing them permanently, their locations are given here;

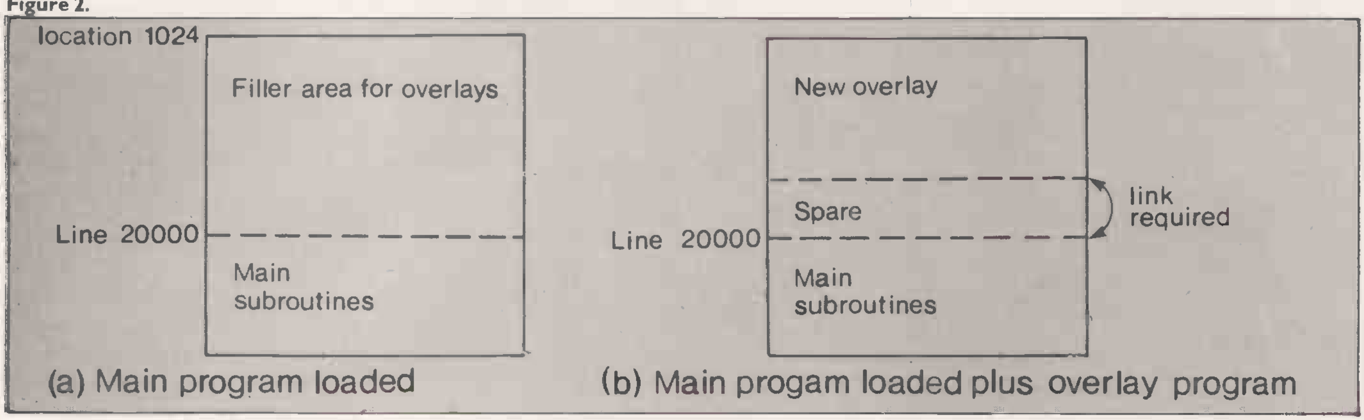
HEX LOCATION	CURRENT VALUE	FUNCTION
7490	50	Sought line number LO
74BE	46	Sought line number HI
74D3	43	Main program link address LO
74DD	06	Main program link address HI

Listing

```
7470        AD 01 04  LDA   Get base address from
7473        85 01     STA   0401 and 0402 and store
7475        AD 02 04  LDA   as address LO in 01
7478        85 02     STA   as address HI in 02
747A  START A5 01     LDA   Get base address LO
747C        18        CLC   Clear carry
747D        69 02     ADC # 2 Add to base address LO to get
747F        85 01     STA   location of line number LO
7481        85 4B     STA   and store in 01 and 4B
7483        A5 02     LDA   Get base address HI, add carry
7485        69 00     ADC 0   if any.
7487        85 02     STA   Store line address HI
7489        85 4C     STA   in 02 and 4C
748B        A2 00     LDX #0 Set register X to zero.
748D        A1 01     LDA(X)  Load Acc with value of contents
748F        C9 50     CMP #$ 50 at 01 and compare to Hex 50
7491        FO 22     BEQ CHECK HI  Branch if equal the CHECK HI
7493  NEXT  38        SEC   Subtract 2 from line addresses.
7494        A5 01     LDA   to restore link address
7496        E9 02     SBC # 2  and
7498        85 01     STA store as LO on 01/4B
749A        85 4B     STA   HI in 02/4C
749C        A5 02     LDA
749F        E9 00     SBC #2
74AO        85 02     STA
74A2        85 4C     STA
74A4        AI 01     LDA(X)  Using current link address
74A6        85 01     STA   get and store next link
74A8        E6 4B     INC   address as LO in 01
74AA        DO 02     BNE
74AC        E6 4C     INC
74AE        A1 4B     LDA(X)
74BO        85 02     STA              HI in 02
74B2        4C 7A 74  JMP   No match found so jump to START
74B5  CHECK HI E6 4B  INC   Having found LO equal 50
74B7        DO 02     BNE   now check line HI
```

(continued on next page)

Figure 2.



(continued from previous page)

		by incrementing
74B9	E6 4C	INC line LO address H1
74BB	A1 4B	LDA(X) fetching and
74BD	C9 46	CMP ✱ $46 comparing to Hex 46
74BF	DO D2	BNE NEXT If not equal branch to NEXT
74C1	38	SEC Subtract 2 to restore
74C2	A5 01	LDA link address
74C4	E9 02	SBC ✱ 2
74C6	85 01	SAT Store LO address in 01/4B
74C8	85 4B	STA
74CA	A5 02	LDA
74CC	E9 00	SBC
74CE	85 02	STA Store HI address in 02/4C
74DO	85 4C	STA
74D2	A9 43	LDA ✱ $43 Load Acc with Hex 43 and
74D4	81 01	STA(X) store in line number 18000
74D6	E6 4B	INC link address LO
74D8	DO 02	BNE
74DA	E6 4C	INC
74DC	A9 06	LDA ✱ $06 Load Acc with Hex 06 and
74DE	81 4B	STA(X) store in line number 18000
74EO	60	RTS link address HI and return

It is reasonably easy to calculate the value for, the sought line number, e.g., 18000 equals Hex 4650. However, to find the main program link address for, say, line number 20000 in another program with a larger filler area, either use the line-find routine on page 71 of *The Pet Revealed* or enter the machine-coded monitor and search up through memory until you find the fourth and fifth value of a Basic line equal to Hex 20 4E equal to 20000. It helps if you make line 20000 something easily identifiable such as Print "clear screen". This will give a monitor line of 4C 06 20 4E 99 22 93 22. The first two are the current link address.

In this limited example, the filler area is only ½K long since the example overlay is only 443bytes. In a real application, certain compromises will have to be made. Obviously, the principal features of the main program are fixed and the only item which expands it is the size of the filler area and the number of first pages of each overlay according to the menu size, which could run to several pages. Also if the maximum size of any overlay is only going to be, say, 5K, why have a filler area of 10K?

One must, therefore, trade off the overlay size against an acceptable access time although I have found that a 10K overlay can be loaded before a typical overlay first page can be read. Another consideration is that if one found that there would be several hundreds of very small overlays, it might be better to simply print "WAIT" on the screen and load the overlay complete with first page as well, since access would not take long.

The possibilities are interesting. I have had overlays which offer a menu to load other overlays and have had an overlay which requests another disc and then offers a 'press any key' which initialises the disc and loads and presents the first menu.

Constructing a database like this enables a microprocessor to exhibit Prestel-like qualities, perhaps using the Find function of utilities such as Toolkit to search through large volumes of data and display the results.

Note that in the listings, CU is cursor up, CD is cursor down, CS is clear screen, CH is cursor home, CR is cursor right, R is reverse on.

Figure 3.

Main program listing.

```
1 POKE52,111:POKE53,116:POKE48,111:POKE49,116
2 IFPEEK(29808)<>173THENLOAD"0:LINK",8
3 IFPEEK(642)<>152THENLOAD"0:REVERSE",8
5 GOTO20000
2110 PRINT"SBSBSBSBSBSBSBSBSBSBSBSBSBS
2120 PRINT"HDHDHDHDHDHDHDHDHDHDHDHDHDH
2130 PRINT"LALALALALALALLALAL  .ALALLL
2140 PRINT"JFJFJFJFJFJFJFJFJI  FJFJFJF
2150 PRINT"MXMXMXMXMXMXMXMXMXMXMXMXMX
2160 PRINT"NCNCNCNCNCNCNCNCNCNCNCNCNN
2170 PRINT"BZBZBZBZBZBZBZBZBZBZBZBZBZ
2180 PRINT"HSHSHSHSHSHSHSHSHSHSHSHSHS
2190 PRINT"KFKFKFKFKFKFKFKFKFKFKKFKK
2200 PRINT"URURURURURURURURURURURURURU
2210 PRINT"LDLDLDLDLDLDLDLDLDLDLDLDLDL
2220 PRINT"ITITITITITITITITITITITITITII
2230 PRINT"URURURURURURURURURURURURURU
2250 PRINT"ORORORORORORORORORORORORORO
20000 PRINT"CS"
20010 PRINT"THE FOLLOWING MENU IS AN EXAMPLE OF HOW"
20020 PRINT"YOUR SELECTION CAN BE LOADED INTO"
20030 PRINT"THE FILLER AREA AND LINKED TO THE MAIN
20040 PRINT"PROGRAM AUTOMATICALLY."
20050 PRINT:PRINT:PRINT:PRINT
20500 PRINT"1    OVERLAY ONE
20505 PRINT"2    OVERLAY TWO
20510 PRINT"3    OVERLAY THREE
20515 PRINT"4    OVERLAY FOUR
20520 PRINT"5    OVERLAY FIVE
20525 PRINT"6    OVERLAY SIX
20530 PRINT"7    OVERLAY SEVEN
20535 PRINT"8    OVERLAY EIGHT
20540 PRINT
20545 PRINT"          TYPE THE NUMBER REQUIRED"
20551 POKE158,0
20560 GETZ$:IFZ$=""THEN20560
20580 IFZ$="1"THEN25500
20581 IFZ$="┴"THEN25500
20582 IFZ$="2"THEN26500
20583 IFZ$="┬"THEN26500
20584 IFZ$="3"THEN27000
20585 IFZ$="┤"THEN27000
20586 IFZ$="4"THEN27500
20587 IFZ$="| "THEN27500
20588 IFZ$="5"THEN28000
20589 IFZ$="| "THEN28000
20590 IFZ$="6"THEN28500
20591 IFZ$=" |"THEN28500
20592 IFZ$="7"THEN29000
20593 IFZ$="¯"THEN29000
20594 IFZ$="8"THEN29500
20595 IFZ$="¯"THEN29500
20610 FORK=1TO5:PRINT"CU 8CR   KEY CORRECT NUMBER         "
20615 FORJ=1TO100:NEXTJ
20620 PRINT"CU 8CR   RKEY CORRECT NUMBER" :FORJ=1TO100:NEXTJ
20625 NEXTK
20630 POKE158,0:PRINT"CU 8CR   TYPE THE NUMBER REQUIRED   "
20640 GOTO20551
```

Overlay listing.

```
5 SYS(29808)
10 GOSUB41000
20 GOSUB40000
30 PRINT"CS"
40 PRINT"OVERLAY ONE-PAGE TWO
50 PRINT:PRINT:PRINT:PRINT:PRINT"          THE REST OF THIS PAGE
60 PRINT"WOULD BE FILLED WITH DATA.
70 GOSUB41000
80 GOSUB40000
90 PRINT"CS"
100 PRINT"OVERLAY ONE-PAGE THREE
150 PRINT:PRINT:PRINT:PRINT:PRINT"          THE REST OF THIS PAGE
160 PRINT"WOULD BE FILLED WITH DATA.
170 GOSUB41000
180 GOSUB40000
190 PRINT"CS"
200 PRINT"OVERLAY ONE-PAGE FOUR
250 PRINT:PRINT:PRINT:PRINT:PRINT"          THE REST OF THIS PAGE
260 PRINT"WOULD BE FILLED WITH DATA.
270 GOSUB41000
280 GOSUB40000
290 GOTO20000
19000 PRINT
READY.


25500 PRINT"CS"
25510 PRINT"OVERLAY ONE
25520 PRINT"
25530 PRINT"THIS IS PAGE ONE OF THE ABOVE OVERLAY.
25540 PRINT"WHILE YOU ARE READING THIS THE REMAINING";
25550 PRINT"PAGES ARE BEING LOADED INTO THE FILLER
25560 PRINT"AREA. WHEN THESE OTHER PAGES ARE IN MAIN";
25570 PRINT"MEMORY THEY WILL THEN DISPLAY AT THE
25580 PRINT"BOTTOM OF THE PAGE 'PRESS ANY LETTER
25590 PRINT"TO CONTINUE' AND 'PRESS ANY NUMBER
25600 PRINT"FOR MENU'
25610 LOAD"0:OVERLAY1",8
25615 PRINT"CS"
26510 PRINT"OVERLAY TWO
26520 PRINT"
26530 PRINT"THIS IS PAGE ONE OF THE ABOVE OVERLAY.
26540 PRINT"WHILE YOU ARE READING THIS THE REMAINING
26550 PRINT"PAGES ARE BEING LOADED INTO THE FILLER
26560 PRINT"AREA. WHEN THESE OTHER PAGES ARE IN MAIN
26570 PRINT"MEMORY THEY WILL THEN DISPLAY AT THE
26580 PRINT"BOTTOM OF THE PAGE "PRESS ANY LETTER
26590 PRINT"TO CONTINUE" AND "PRESS ANY NUMBER
26600 PRINT"FOR MENU"
26610 LOAD"0:OVERLAY2",8

              THE OTHER PAGES WOULD BE ENTERED HERE"

40000 POKE714,13:POKE715,128:POKE716,23:POKE717,1:POKE718, 6
40010 I=0:POKE158,0
40011 I=I+1:IFI>20THEN20000
40012 GETZ$:IFZ$<>""THEN40021
40013 SYS(722):FORJ=1TO500:NEXT:SYS(722):FORJ=1TO500:NEXT
40014 GETZ$:IFZ$<>""THEN40021
40015 POKE716,24:SYS(722):FORJ=1TO500:NEXT
40016 GETZ$:IFZ$<>""THEN40021
40017 SYS(722):FORJ=1TO500:NEXT:POKE716,23:GETZ$:IFZ$=""THEN40011
40021 A=ASC(Z$):IF(A>64ANDA<91)OR(A>192ANDA<219)THENRETURN
40022 IF(A>47ANDA<58)OR(A>175ANDA<186)THEN20000
40030 GOTO40010
41000 PRINT"CH    23CD     4CR          PRESS ANY LETTER TO CONTINUE"
41001 PRINT"4CR PRESS ANY NUMBER FOR MENU CU"
41010 RETURN
```

Essential tools for repetitive sums

ANALYTICALLY, if we let Cn be the number of comparisons made in sorting n elements, and let Mn be the number of movements or exchanges made, then considering a randomly-unsorted collection of n items:

Bubble-sort:
$Cn = (n^2 - n)/2$ $Mn = 3(n^2 - n)/4$

Insertion:
$Cn = (n^2 + n - 2)/4$ $Mn = (n^2 - 9n - 10)/4$

To give an example, Bubble-sort will, on average, make no less than 1,248,750 comparisons and exchanges in sorting 1,000 numbers.

From these results, we say that the complexity of computation in both Bubble-sort and Straight Insertion sort is of order n squared. In contrast, that of Shell-sort is approximately of order n to the power (1.2), and though a vast improvement, it is still slow when we

by Mark Walker

appreciate that complexities of order (n log n) are theoretically possible. We therefore illustrate one of the fastest sorting algorithms, Quick-sort — see table 1.

Quick-sort was developed by CAR Hoare and like all the best algorithms, it is fundamentally simple. Given n objects a1 . . . an to be sorted in an array A, we choose an element x from them and construct a partition of A into A1 and A2 where:

A1 = (ai : ai > x)
A2 = (ai : ai <= x)

and then construct partitions of A1 and A2 based on new elements x1, x2 chosen from them, and so on. The array A becomes sorted when the partitions are of unit size.

It is usual to choose each x as the middle, median element of the partition considered. This is because if x is the median of the array, both the best and average performance of the algorithm and good, since a random number tends to lie near the median.

The algorithm lends itself very easily to a recursive definition, and a procedure to perform Quick-sort is given in a slightly-altered form of BCPL — with [] replacing! Conversion to Pascal is easy.

```
LET quicksort (low,up,array) BE $(
        LET k,J = low,up
        LET x = array[ (low+up)/2 ]
        WHILE k<=J DO $(
                WHILE array[k]<x DO k := k + 1
                WHILE x<array[J] DO j := j - 1
                IF k<=j THEN $(
                        LET y=array[k]
                        array[k] := array[j]
                        array[j] := y
                        k := k + 1
                        j := j - 1
                $)
        $)
        IF low<J THEN quicksort(low,j,array)
        IF k<up THEN quicksort(k,up,array)
$)
and is called with    quicksort(1,n,A)
```

The listing in Basic is much less clear, due mainly to Basic's lack of local variables, and is consequently non-recursive. It assumes the data to be sorted is in an array A of N elements. M is a constant for a stack composed of two arrays SL.SR which contain the left and right bounds of the current partition to be further partitioned. S is the point of most recent entry to this stack.

Since the following code is of itself difficult, the routine should merely be copied line for line when required. The recursive version should be studied since it neatly embodies the essentials of the Quick-sort algorithm.

```
  5 REM NON-RECURSIVE QUICKSORT ROUTINE
100 M=12 : DIM SL(M),SR(M)
110 S=1 : SL(1)=1 : SR(1)=N
115 REM TAKE TOP REQUEST FROM STACK
120 L=SL(S) : R=SR(S) : S=S-1
125 REM SPLIT A(1) ... A(R)
130 I=L : J=R : X=A( INT((L+R)/2) )
140 IF A(I)<X THEN I=I+1 : GOTO 140
150 IF X<A(J) THEN J=J-1 : GOTO 150
160 IF I>J THEN 190
170 W=A(I) : A(I)=A(J) : A(J)=W
180 I=I+1 : J=J-1
190 IF I<=J THEN 140
200 IF I>=R THEN 220
205 REM STACK REQUEST TO SORT RIGHT PARTITION
210 S=S+1 ! SL(S)=I : SR(S)=R
220 R=J.
230 IF L<R THEN 130
240 IF S<>0 THEN 120
```

Consideration of table 1 shows how great an improvement Quick-sort is over the elementary sorting algorithms.

Numerical analysis is a major area of activity for computers, since it involves large quantities of repetitive computation to solve systems of linear equations, differential equations or partial differential equations. Matrices and determinants are essential tools in this area, so we pause briefly to consider each in turn.

Matrices can be thought of as a shorthand method of writing a grid of numbers, usually equation coefficients. They have no value, and are usually represented as a two-dimensional array. A determinant is also a grid of numbers, but has a single value which may be computed thus:

Set of Equations:
$$3x - 2y + z = 7$$
$$x + 5y - z = 9$$
$$x - y + 4z = -2$$

Matrix of coefficients: Determinant:

$$\begin{bmatrix} 3 & -2 & 1 \\ 1 & 5 & -1 \\ 1 & -1 & 4 \end{bmatrix} \qquad \begin{vmatrix} 3 & -2 & 1 \\ 1 & 5 & -1 \\ 1 & -1 & 4 \end{vmatrix} = 61$$

Table 1. Time in ms. to sort 512 keys in a CDC6400 Pascal implementation.

	Ordered	Random order	Inverse order
Straight insertion	23	1444	2386
Binary Insertion	125	1027	2090
Bubble-sort with flag	8	4270	6542
Shaker-sort	9	3642	6520
Quick-sort	69	146	79

Operations on matrices are very simple, the following routine adds matrices A and B — each N × N elements — to give matrix C, subtracts them to give D, multiplies them to give E and transposes A to give F.

```
100 FOR I=1 TO N
110 FOR J=1 TO N
120 C(I,J) = A(I,J) + B(I,J)
130 D(I,J) = A(I,J) - B(I,J)
140 E(I,J)=0 : FOR K=1 TO N
150 E(I,J) = E(I,J) + A(I,K) * B(K,J)
160 NEXT K
170 F(I,J) = A(J,I)
180 NEXT J,I
```

Matrices need not be square. Generally, if a matrix has r rows and c columns then it is a (r × c) matrix. Matrices may be added and subtracted only if they are the same size. Two matrices may be multiplied only if they conform to the rule:

$$(p \times m) . (m \times n) = (p \times n)$$

Any matrix may be transposed.

We now consider the evaluation of determinants, the mathematics is well covered in the references, and the program emulates the process shown in table 2.

Essentially then, we reduce the determinant successively from an N × N to a 1 × 1. The value of the determinant is then this value multiplied by the scaling factors removed. These factors are removed to make the largest element in the column unity, rows are exchanged to ensure that this element is on the diagonal for reasons of numerical stability. Appropriate multiples of this column are added to the others to reduce their upper elements to zero as shown.

In this routine, A is an N × N array whose determinant is to be evaluated in D. This method uses a form of Gaussian elimination with partial pivoting, a technique explained more fully when considering solution of equations. Note that the routine does not preserve the matrix A.

```
  5 REM DETERMINANT EVALUATION ROUTINE
100 D=1
110 FOR I=1 TO N
115 REM PLACE MAX. COEF. OF ROW I ON DIAGONAL
120 R=I : M=A(I,I)
130 FOR K=I+1 TO N
140 IF A(I,K)<=M THEN 160
150 M=A(I,K) : R=K
160 NEXT K
165 REM IF ZERO THEN FINISH
170 IF M=0 THEN D=0 : GOTO 330
180 IF R=I THEN 230
185 REM MAX. COEF. NOT ON DIAGONAL SO SWOP ROWS
190 FOR K=1 TO N
200 M=A(K,I) : A(K,I)=A(K,R) ; A(K,R)=M
210 NEXT K
215 REM DETERMINANT CHANGES SIGN AS ROWS SWOPPED
220 D=-D
225 REM REMOVE SCALING FACTOR
230 D=D * A(I,I)
240 IF I=N THEN 330
245 REM DIVIDE TO MAKE PIVOTAL ELEMENT UNITY
250 FOR J=N TO I STEP -1
260 A(I,J)=A(I,J) / A(I,I)
270 NEXT J
280 FOR J=I+1 TO N
285 REM SET MULTIPLIER FOR NEXT ROW
290 M = -A(J,I)
300 FOR K=I TO N
310 A(J,K) = A(J,K) + A(I,K) * M
320 NEXT K,J,I
330 PRINT 'VALUE OF DETERMINANT IS ';D
```

(continued on next page)

(continued from previous page)

The inverse of a matrix A is denoted A^{-1} and is such that

where $$AA^{-1} = I$$

$$I = \begin{bmatrix} 1 & 0 & \dots & 0 & 0 \\ 0 & 1 & \dots & 0 & 0 \\ : & : & \dots & : & : \\ : & : & \dots & : & : \\ 0 & 0 & \dots & 1 & 0 \\ 0 & 0 & \dots & 0 & 1 \end{bmatrix}$$

and is known as the Identity matrix since AI = IA = A. The inverse of a matrix A can be built from an identity matrix — B in the following routine — using Gaussian elimination. The routine builds the inverse of an N×N matrix A in an N×N matrix B. Note A is not preserved by the routine.

```
  5 REM MATRIX INVERSION ROUTINE
100 FOR I=1 TO N : FOR J=1 TO N
105 REM FORM AN IDENTITY MATRIX IN B
110 B(I,J)=1 - ABS(SGN(I - J))
120 NEXT J,I
130 FOR I=1 TO N-1
140 IF A(I,I)=0 THEN PRINT"ABORTING" : END
150 FOR J=I+1 TO N
160 M=A(J,I) / A(I,I)
170 FOR K=1 TO N
180 A(J,K)=A(J,K) - M * A(I,K)
190 B(J,K)=B(J,K) - M * B(I,K)
200 NEXT K,J,I
205 REM PERFORM BACKSUBSTITUTION IN B
210 FOR I=N TO 1 STEP -1
220 FOR K=1 TO N
230 FOR J=I+1 TO N
240 B(I,K)=B(I,K) - A(I,J) * B(J,K)
250 NEXT J
260 B(I,K)=B(I,K) / A(I,I)
270 NEXT K,I
```

The routine does not include partial pivoting, it may be included to give numerical stability. Inverses are not often

Given a set of n linear equations of the form:

$$a_{11}x_1 + a_{12}x_2 + \dots + a_{1n}x_n = b_1$$
$$a_{21}x_2 + a_{22}x_2 + \dots + a_{2n}x_n = b_2$$
$$\vdots \qquad \vdots \qquad \vdots$$
$$a_{n1}x_1 + a_{n2}x_2 + \dots + a_{nn}x_n = b_n$$

which may be represented in matrix form as:

$$\begin{bmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ \vdots & \vdots & & \vdots \\ a_{n1} & a_{n2} & \dots & a_{nn} \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ x_n \end{bmatrix} = \begin{bmatrix} b_1 \\ b_2 \\ \vdots \\ b_n \end{bmatrix}$$

or alternatively as:

$$A.X = B$$

Mathematical solutions include Cramer's Rule, usually taught in schools, whereby the solution is given by:

$$x_i = \frac{\det(A_i)}{\det(A)}$$

where: det() is the evaluation of a determinant

Ai is the matrix A with its i th. column replaced by the matrix B

However, it can be shown that the number of computations required by this method is 1.5(n+1)! multiplications, n divisions and (n+1)! additions/subtractions for n equations. With 15 equations the solution would require about three months. Also, solving by:

$$X = A^{-1}B$$

where:

$$A^{-1} = \frac{\operatorname{adj}(A)}{\det(A)}$$

```
: 3 -2  1 :      :  1 -2  1 :      : 1     0     0 :
:         :      :          :      :               :
: 1  5 -1 : = 3 : 1/3  5 -1 : = 3 : 1/3 17/3 -4/3 : = 3 : 17/3 -4/3 :
:         :      :          :      :               :     :           :
: 1 -1  4 :      : 1/3 -1  4 :     : 1/3 -1/3 11/3 :     : -1/3 11/3 :

       :  1     -4/3 :        :  1       0    :
  = 17 :             : =  17 :                :  =  61
       : -1/17  11/3 :        : -1/17  61/17  :
```

Table 2.

requires as much computational effort as Cramer's rule.

There are two practical forms of solution, by elimination and factorisation. Gaussian elimination is a prime example of the first of these. Essentially, the system of n simultaneous equations can be solved by subtracting multiples of the equations from each other to derive a new system of equations with its matrix in upper triangular form. Suppose a_{11} is the element of largest modulus in column 1 — if a_{k1} is the largest, exchange the k th. and first equations. Subtract $m_{21} = a_{21}/a_{11}$ times the first equation from the second, $m_{31} = a_{31}/a_{11}$ times the first equation from the third and so on to give:

$$\begin{bmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ 0 & c_{22} & \dots & c_{2n} \\ \vdots & \vdots & & \vdots \\ 0 & c_{n-12} & \dots & c_{n-1n} \\ 0 & c_{n2} & \dots & c_{nn} \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ x_{n-1} \\ x_n \end{bmatrix} = \begin{bmatrix} b_1 \\ d_2 \\ \vdots \\ d_{n-1} \\ d_n \end{bmatrix}$$

Suppose c_{22} is the element of largest modulus in column 2 — ignoring a_{12} — subtract $m_{32} = c_{32}/c_{22}$ times the second equation from the third, $m_{42} = c_{42}/c_{22}$ times the second equation from the fourth and so on .

After n-1 stages, the system becomes:

$$\begin{bmatrix} a_{11} & a_{12} & \dots & a_{1n-1} & a_{1n} \\ 0 & c_{22} & \dots & c_{2n-1} & c_{2n} \\ \vdots & \vdots & & & \\ 0 & 0 & \dots & p_{n-1n-1} & p_{n-1n} \\ 0 & 0 & \dots & 0 & Q_{nn} \end{bmatrix} \begin{bmatrix} x1 \\ x_2 \\ \vdots \\ x_{n-1} \\ x_n \end{bmatrix} = \begin{bmatrix} b_1 \\ d_2 \\ \vdots \\ r_{n-1} \\ s_n \end{bmatrix}$$

The solution of the equations is now completed using a backsubstitution process:

$$x_n = s_n/q_{nn}$$
$$x_{n-1} = (r_{n-1} - p_{n-1n}x_n)/p_{n-1n-1}$$

and so on.

The following routine solves the system of N simultaneous linear equations in array A, with right-hand side coefficients in B. X is the solution array. Note that the routine does not check whether a unique solution actually exists, this is so if det (A) <> 0.

```
  5 REM GAUSSIAN ELIMINATION ROUTINE
100 FOR I=1 TO N-1
110 R=I : M=A(I,I)
115 REM FIND ELEMENT OF LARGEST MODULUS
120 FOR J=I+1 TO N
130 IF A(J,I)<=M THEN 150
140 R=J : M=A(I,J)
150 NEXT J
160 IF M=0 THEN PRINT "SOLUTION ABORTED" : END
170 IF R=I THEN 230
180 FOR K=1 TO N
190 S=A(I,K) : A(I,K)=A(R,K) : A(R,K)=S
200 NEXT K
220 S=B(I) : B(I)=B(R) : B(R)=S
230 FOR J=I+1 TO N
240 M=A(J,I)/A(I,I)
250 FOR K=I TO N
260 A(J,K)=A(J,K) - M * A(I,K)
270 NEXT K
280 B(J)=B(J) - M * B(I)
290 NEXT J,I
295 REM PERFORM BACKSUBSTITUTION FOR X
300 X(N)=B(N) / A(N,N)
310 FOR I=N-1 TO 1 STEP -1
320 S=0 : FOR J=I+1 TO N
330 S=S + X(J) * A(I,J)
340 NEXT J
350 X(I)=(B(I) - S) / A(I,I)
360 NEXT I
```

Solving the equations by $X = A^{-1}B$ where A^{-1} is calculated using the previous routine is an equivalent process, but requires in addition multiplication of the inverse matrix by B. This introduces additional sources of error and is not recommended.

Were we solving a set of systems of linear equations AXi = Bi for i = 1,2..m, Gaussian elimination would be a poor method to use since we could have to calculate A m times. For this reason, and since it is a more accurate method, we examine LU Factorisation developed by Crout.

In this method we factorise A so that A = LU

$$\text{where } L = \begin{bmatrix} 1 & 0 & \dots & 0 & 0 \\ l_{21} & 1 & \dots & 0 & 0 \\ l_{31} & l_{32} & \dots & 0 & 0 \\ & : & : & & \\ l_{n-11} & l_{n-12} & \dots & 1 & 0 \\ l_{n1} & l_{n2} & \dots & l_{nn-1} & 1 \end{bmatrix}$$

$$\text{and } U = \begin{bmatrix} u_{11} & u_{12} & \dots & u_{in-1} & u_{in} \\ 0 & u_{22} & \dots & u_{2n-1} & u_{2n} \\ 0 & 0 & \dots & u_{3n-1} & u_{3n} \\ & : & & : & \\ 0 & 0 & \dots & u_{n-1n-1} & u_{n-1n} \\ 0 & 0 & \dots & 0 & u_{nn} \end{bmatrix}$$

To solve AX = B for X, we substitute A = LU, then LUX = B, and if we let LZ = B, then UX = Z.

Now we can solve for Z and X very simply, since the matrices L and U are in triangular form, we merely use forward substitution on L for Z and backward substitution on U for X.

The advantage of this method is a considerable saving in time if solving a set of systems of equations, since L and U are only derived once. Consider a set of such systems:

$AX_1 = B_1, AX_2 = B_2, \dots\dots, AX_m = B_m$

if all the Bs are known at the same time, the Gaussian and LU methods are equivalent; if they are not, the Gaussian method requires m computations of A to derive the m reduced B matrices. The LU method requires only one pair of L,U matrices since it performs substitution directly for the solution. Row interchanges are not needed either by the LU method assuming maximum machine precision is used since rounding errors are not given the chance to build up, this speeds the method further.

In this routine below, the coefficient matrix A (N × N) is factorised into two (N × N) matrices L and U. With large systems of equations it would be worth combining both L and U into a single matrix C of order (N × N+1). I have not done so to make the routine easier to understand.

$$
\begin{bmatrix}
u_{11} & u_{12} & \cdots & u_{in-1} & u_{in} \\
1 & u_{22} & \cdots & u_{2n-1} & u_{2n} \\
1_{21} & 1 & \cdots & u_{3n-1} & u_{3n} \\
1_{31} & 1_{22} & \cdots & u_{4n-1} & u_{4n} \\
 & \vdots & & \vdots & \\
1_{n-21} & 1_{n-22} & \cdots & u_{n-1n-1} & u_{n-1n} \\
1_{n-11} & 1_{n-12} & \cdots & 1 & u_{nn} \\
1_{n1} & 1_{n2} & \cdots & 1_{nn-1} & 1_{n}
\end{bmatrix}
$$

```
  5 REM LU FACTORISATION AND SOLN. ROUTINE
100 FOR I=1 TO N
105 REM FACTORISE A INTO L AND U
110 FOR J=1 TO N
120 S=0
130 IF J<I THEN 260
140 IF J=I THEN 200
150 FOR K=1 TO I-1
160 S=S + L(I,K) * U(K,J)
170 NEXT K
180 U(I,J)=A(I,J) - S
190 GOTO 300
200 FOR K=1 TO I-1
210 S=S + L(I,K) * U(K,I)
220 NEXT K
230 U(I,I)=A(I,I) - S
240 IF ABS(U(I,I))<.0000001 THEN PRINT'SINGULAR MATRIX':END
250 GOTO 300
260 FOR K=1 TO J-1
270 S=S + L(I,K) * U(K,J)
280 NEXT k
290 L(I,J)=(A(I,J) - S) / U(J,J)
300 NEXT J,I
310 REM SOLVE EQUN. LZ=B BY FORWARD SUBSTITUTION
320 Z(1)=B(1)
330 FOR I=2 TO N
340 S=0 : FOR K=1 TO I-1
350 S=S + L(I,K) * Z(K)
360 NEXT K
370 Z(I)=B(I) - S
380 NEXT I
390 REM SOLVE EQUN. UX=Z BY BACK SUBSTITUTION
400 X(N)=Z(N) / U(N,N)
410 FOR I=N-1 TO 1 STEP -1
420 S=0 : FOR J=I+1 TO N
430 S=S + X(J) * U(I,J)
440 NEXT J
450 X(I)=(Z(I) - S) / U(I,I)
460 NEXT I
```

The following routine fits polynomials to a set of data points. A polynomial is any equation of the form:

$f(x) = a0 + a1*x + a2*x^2 + \ldots + an*x^n$

and the best fit of such a function to a set of data points is the curve which passes, on average, closest to all such points. The simplest version of this is producing the best straight line for a set of data points. The routine uses a form of least square fit, but mathematically it is somewhat complex.

```
  5 REM CURVE-FITTING ROUTINE
100 INPUT 'ENTER HIGHEST DEGREE OF POLYNOMIAL TO BE FITTED';D
110 IF D<1 THEN 100
120 INPUT 'ENTER NUMBER OF DATA POINTS';N
130 IF N<1 THEN 120
140 DIM A(N,N),B(N),C(N),X(N),Y(N),E(N),S(N)
150 FOR I=1 TO N
160 PRINT 'ENTER X,Y CO-ORDINATES OF POINT ';I
170 INPUT X(I),Y(I)
180 NEXT I
190 FOR D=D TO 1 STEP -1 : Y1=0
200 FOR J=1 TO N : FOR I=1 TO D
210 B(I)=B(I) + Y(J) * X(J)^I
220 FOR K=1 TO D
230 A(I,K)=A(I,K) + X(J)^(I+K)
240 NEXT K
250 S(I)=S(I) + X(J)^I
260 NEXT I
270 Y1=Y1 + Y(J)
280 NEXT J
290 FOR I=1 TO D : FOR J=1 TO D
300 A(I,J)=A(I,J) - S(I) * S(J) / N
310 NEXT J
320 B(I)=B(I) - Y1 * S(I) / N
330 NEXT I
340 FOR K=1 TO D
350 R=K : A1=0
360 FOR L=K TO D
370 A2=ABS(A(L,K))
380 IF A2>A1 THEN A1=A2 : R=L
390 NEXT L
400 IF A1=0 THEN PRINT 'ZERO COEF. IN 'A' MATRIX' : END
410 IF R=K THEN 460
420 FOR J=K TO D
430 X1=A(R,J) : A(R,J)=A(K,J) : A(K,J)=X1
440 NEXT J
450 X1=B(R) : B(R)=B(K) : B(K)=X1
460 FOR I=K TO D
470 M=A(I,K)
480 FOR J=K TO D
490 IF I=K THEN A(I,J)=A(I,J) / M
500 IF I<>K THEN A(I,J)=A(I,J) - M * A(K,J)
510 NEXT J
520 IF I=K THEN B(I)=B(I) / M
530 IF I<>K THEN B(I)=B(I) - M * B(K)
540 NEXT I,K
550 E(D)=B(D)
560 FOR K=1 TO D-1
570 I=D - K : S1=0
580 FOR J=1 TO D
590 S1=S1 + A(I,J) * E(J)
600 NEXT J
610 E(I)=B(I) - S1
620 NEXT K
630 PRINT 'POLYNOMIAL DEGREE ';D;' COEFFICIENTS ARE'
640 S1=0 : FOR I=1 TO D
650 S1=S1 + E(I) * S(I) / N
660 NEXT I
670 PRINT 'A0 = ';Y1/N-S1
680 FOR P=1 TO D
690 PRINT 'A';P;' = ';E(P)
700 NEXT P
710 FOR I=1 TO N : FOR J=1 TO N
720 A(I,J)=0 : NEXT J
730 B(I)=0 : S(I)=0 : E(I)=0
740 NEXT I
750 NEXT D
```

Beware of the possibility of overflow with such lines as 210,230 and 250 in the routine, and use the maximum machine accuracy possible to reduce the effects of exponentiation-rounding errors.

The subject of random numbers have received much attention of late, particularly in reference to the Pet RND(n) function. We introduce the congruential generator as an example of a generator which produces reasonable pseudo-random numbers.

The essence of this generator is a seed, which is in the range of 0 to 10000. The routine will ask for this before generating numbers in the same interval, but ideally the seed should be machine-determined. A suitable source for the seed on the Pet is the system clock TI.

```
100 INPUT 'ENTER SEED (0<X<10000) ';S
110 IF S<0 OR S>10000 THEN 100
120 INPUT'ENTER NUMBER OF PSEUDO RANDOM
    NUMBERS REQUIRED';N
130 IF N<0 THEN 120
140 FOR I=1 TO N
145 REM MULTIPLY SEED BY PRIME
150 S=S*23
155 REM EXPRESS SEED MODULO LARGE NUMBER
    AND FORCE IN RANGE 0->10000
160 R=S - INT(S/10001)*10001
170 S=R : PRINTI;'TH.RANDOM NUMBER IS ';S
180 NEXT I
```

References

Sorting and Searching by Knuth.
Algorithms Data Structure = Programs by N Wirth.
Mathematics for Scientists and Engineers by A Jeffries.
BCPL the language and its compiler by M Richards and C Whitby-Stevens.

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String routines

JEFF TOCK'S contribution to the Z-80 Zodiac in the April 1981 issue of *Practical Computing* caught my eye as a very useful subroutine and apart from an error in line 200 was soon in RAM and running, writes John Attfield of Benfleet, Sussex.

However, I felt that it should be possible, using string manipulation, to achieve the same result in less space. The result as you can see confirms this and apart from the statement

SCREEN X, Y

in line 270, the program should run on almost any machine with string-handling facilities. The program is easily extended using string arrays to display any number of strings following each other in an endless loop.

Variables:

A = counter
D = delay speed
L = string length
X & Y screen co-ordinates
A$ = main string
B$ = right of string
C$ = left of string

```
200 A=0:X=10:Y=7:D=200
210 CLS
220 A$="TICKER TAPE TEST STRING"
230 L=LEN(A$)
240 A=A+1:IF A=L THEN A=1
250 B$=RIGHT$(A$,L—A)
260 C$=LEFT$(A$,A)
270 SCREENX, Y:PRINTB$+C$
280 FOR C=1TOD:NEXTC
290 GOTO240
```

More instructions

IF YOU are a user of the Z-80 microprocessor at assembly level, then you should have been reading David Peckett's series on machine code. Shame on you if you have not, writes Kieron Leech of Warrington, Cheshire.

However, he has missed a very interesting point, namely it has more instructions than Zilog tells you. For example, if you look at the list of rotate and shift instructions you will see:

RL	Rotate left
RLC	Rotate left, copy bit 7 into carry
RR	Rotate right
RRC	Rotate right, copy bit 0 into carry
SLA	Shift left arithmetic
SRA	Shift right arithmetic
SRL	Shift right logical

You should be able to see that there is an odd one out, SLA. It has no "SLL", shift left logical going with it. In fact, one exists. When Zilog wrote the original specifications for the Z-80, a shift left logical was included.

Unfortunately, when the microprocessor was tested, it was found that the "SLL" function did not work. Rather than spending thousands trying to correct it, it was simply omitted from the specifications. The nature of its failure is very simple, however, and easy to correct. If you look at the Shift right logical you will see it does

0 ——→ [7 0] ——→ CY

or so the programming manual tells us. If you try the "SLL" you will see that it does this:

CY ←—— [7 0] ←—— 1

It puts a 1 in bit 0 where it should put a 0. This is easily corrected by a re-set of the affected bit. The codes for our new instruction, "SLL", are in table 1 — a total of 10. They will probably be of use sometimes, if you remember where they go wrong. However, there is more to the Z-80 than this. If you look through the programming manual at the way the IX and IY registers are used, you can see some very interesting happenings. For example:

LD A,(HL)	7E	
LD A,(IX + IND)	DD 7E XX	Where
ADD A,(HL)	86	XX = IND
ADD A,(IX + IND)	DD 86 XX	

etc., the same for IY,DD replaced by FD

It appears that normal codes which "drive" the HL register pair, drive the IX register if they are prefixed by "DD", and IY if they are prefixed by "FD".

The reason for this could be as follows. If we assume there are two two-bit address pointers in the Z-80, P1 and P2, behaving something like the IFF1 and IFF2 flip-flops used for interrupts. Normally, P1 decides which register the instructions for "HL" will go to, "DE", "HL", "IX" or "IY".

The reason "DE" is included is that the "EX DE, HL" instruction only takes four clock periods to execute, and since it takes that many clock periods to move the data in one eight-bit register to another I do not think it has enough time to swap two 16-bit registers around. All it probably has time for is to change that pointer so that instructions for "DE" are now routed to "HL", and *vice versa*.

Now "DD" seems to save P1 in P2 so it can be recalled when the instruction concerning IX has finished, and then it forces its own code into P1 so that the next "HL" instruction operates on "IX". "FD" will do a similar thing, but for "IY" instead of "IX".

If you look in the Zilog programming manual, however, not all the "HL" codes seem to have equivalent "IX" andd "IY" codes. It seems worthwhile, therefore, to put "DD" and "FD" in front of these "HL" only instructions and see what happens.

In fact, it gives you an extra 88 instructions. Most of these seem to operate on the low- and high-order bytes of "IX" and "IY" individually, treating them exactly the same as "HL", i.e., splittable into two eight-bit registers. See table 2 for all the new codes.

Not all the codes we might expect to work, however, do. In particular, the prefix "ED" seems to re-set P1 so that the following instruction is not transferred to "IX" or "IY". I cannot make the rotate and shift instructions work either — they do nothing. It should also be obvious that you cannot say anything like "EX DE,IX", since the exchange instruction changes P1.

Table 1.

Shift Left Logical — SLL. This is the instruction Zilog wrote out of the Z-80 specifications because it did not work properly. It was supposed to place bit 7 of the byte operated on into the carry flag, shift the byte left then place a 0 in bit 0 but instead it places a 1 there.

SLL (HL)	CB 36	
SLL(IX) + IND)	DD CB XX 36	Where XX
SLL (IY + IND)	FD CB XX 36	= IND
SLL A	CB 37	
SLL B	CB 30	
SLL C	CB 31	
SLL D	CB 32	
SLL E	CB 33	
SLL H	CB 34	
SLL L	CB 35	

Condition bits affected

S:	Set if result is negative, re-set otherwise
Z:	Set if result is zero, re-set otherwise
H:	Re-set
P/V:	Set if parity even, re-set if parity odd
N:	Re-set
C:	Data from bit 7 of source

Table 2 is a list of the 'new' op-codes operating on the IX and IY registers.

The list is in numerical order.

DD 24	FD24	INC IXH	INC IYH
DD 25	FD 25	DEC IXH	DEC IYH
DD 26 nn	FD26nn	LD IXH,n	LD IYH,n
DD 2C	FD2C	INC IXL	INC IYL
DD 2D	FD 2D	DEC IXL	DEC IYL
DD 2E nn	FD2Enn	LD IXL,n	LD IYL,n
DD 44	FD 44	LD B,IXH	LD B,IYH
DD45	FD 45	LD B,IXL	LD B, IYL
DD 4C	FD 4C	LD C,IXH	LD C,IYH
DD4D	FD4D	LD C, IXL	LD C, IYL
DD 54	FD 54	LD D,IXH	LD D,IYH
DD55	FD 55	LD D,IXL	LD D IYL
DD 5C	FD 5C	LD E,IXH	LD E,IYH
DD 5D	FD 5D	LD E,IXL	LD E,IYL
DD 60	FD 60	LD IXH,B	LD IYH,B
DD 61	FD 61	LD IXH,C	LD IYH,C
DD62	FD 62	LD IXH,D	LD IYH,D
DD 63	FD 63	LD IXH,E	LD IYH,E
DD 65	FD 65	LDIXY,IXL	LD IYH,IYL
DD 67	FD 67	LD IXH,A	LD IYH,A
DD 68	FD 68	LD IXL,B	LD IYL,B
DD 69	FD 69	LD IXL,C	LD IYL,C
DD 6A	FD 6A	LD IXL,D	LD IYL,D
DD 6B	FD 6B	LD IXL,E	LD IYL,E
DD 6C	FD 6C	LDIXL,IXH	LD IYL,IYH
DD 6F	FD 6F	LD IXL,A	LD IYL,A
DD7C	FD 7C	LD A,IXH	LD A,IYH
DD 7D	FD 7D	LD A,IXL	LD A,IYL
DD 84	FD 84	ADD A,IXH	ADD A,IYH
DD 85	FD 85	ADD A,IXL	ADD A,IYL
DD 8C	FD 8C	ADC A,IXH	ADC A,IYH
DD 8D	FD 8D	ADC A,IXL	ADC A,IYL
DD 94	FD 94	SUBA,IXH	SUB A,IYH
DD 95	FD 95	SUB A,IXL	SUB A,IYL
DD 9C	FD 9C	SBC A,IXH	SBC A,IYH
DD 9D	FD 9D	SBC A,IXL	SBC A,IYL
DD A4	FD A4	AND A,IXH	AND A,IYH
DD A5	FD A5	AND A,IXL	AND A,IYL
DD AC	FD AC	XOR A,IXH	XOR A,IYH
DD AD	FD AD	XOR A,IXL	XOR A,IYL
DD B4	FD B4	OR A,IXH	OR A, IYH
DD B5	FD B5	OR A,IXL	OR A,IYL
DD BC	FD BC	CP A,IXH	CP A,IYH
DD BD	FD BD	CP A,IXL	CP A,IYL

IXH is the highest bits of IX, i.e., bits 8 to 15 IXL if the lowest eight bits of IX, i.e., bits 0 to 7.

The instructions change the flags in the same way the "HL" equivalent instructions do.

Long division

THE SEVERE arithmetic limitations of the ZX-80 present a challenge to one's ingenuity, particularly the inability of the computer to handle any number greater than 32767 and the rounding down to nought in using the computer for division, writes Robin Allott of Seaford, Sussex.

However, by a combination of the use of arrays and loops, these arithmetic limitations can be overcome as the following program for very long division shows; it allows the division of a number of any size by a number of any size, e.g., a 40-figure number by a 20-figure number or by a single-figure number. If one wants to use the program for large numbers it is better run on the ZX-80 with the 16K add-on memory.

The program is very simple to run. After Run, it first calls for ND — the number of digits in the number to be divided — and then for DD — the number of digits in the divisor.

It then calls for X — the number to be divided — input each figure separately — and then for Y — the divisor — input each figure separately. It prints out the answer without initial noughts; the program can be adapted very simply to produce as many decimal places as required.

Telephone pad

HERE IS a program for storing a telephone directory on the ZX-80 using the program listing to store the data, writes MG Ormerod of Reigate, Surrey. This has the advantage over other methods of storing data in that the data is not lost by inadvertently using the Run command. The basic program consists of three lines.

```
10 PRINT "GIVE REQUIRED NAME"
20 INPUT U$
30 GO TO (CODE(U$)—37)*100 + (CODE
   (TL$(U$))—37)*2
```

Each entry of the directory consists of a line number, print instruction and a string giving name and telephone number. When making an entry to the directory, a new line is added to the program. The line number is calculated by taking the first letter of the name and putting A = 1 or B = 2, etc., and then multiplying by 100 and adding the value of the second letter ×2, e.g.,

```
1030 PRINT "JONES","ALAN","01-644-
     9821"
1031 GO TO 20
3826 PRINT "SMITH","JOHN","063-
     8948",,"SMITH","PETER","278-
     4539"
3827 GO TO 20
```

The line number + 1 is used to return control to line 20.

Die cast

IN FEEDBACK, January 1981, Neville Falkiner lists a Double Dice Throwing program, writes Brian Horsfield of Middlesbrough.

Here is a shorter Double Dice Display which fits the basic ZX-80 and allows either die to assume the higher value.

```
  1 REM B.HORSFIELD
 10 LET A$="*.*"
 20 LET B$="*"
 30 LET C$=".*"
 40 LET D$="..*"
 45 CLS
 50 LET X=RND (6)
 60 LET Y=RND (6)
 70 IF X=1 THEN PRINT ,,,,,C$
 80 IF X=2 THEN PRINT ,B$,,,,,,,,D$
 90 IF X=3 THEN PRINT ,B$,,,,C$,,,,D$
100 IF X=4 THEN PRINT ,A$,,,,,,,,A$
110 IF X=5 THEN PRINT ,A$,,,,C$,,,,A$
120 IF X=6 THEN PRINT ,A$,,,,A$,,,,A$
130 IF Y=1 THEN PRINT ,,,,,,C$
140 IF Y=2 THEN PRINT ,,B$,,,,,,,,D$
150 IF Y=3 THEN PRINT ,,B$,,,,C$,,,,D$
160 IF Y=4 THEN PRINT ,,A$,,,,,,,,A$
170 IF Y=5 THEN PRINT ,,A$,,,,C$,,,,A$
180 IF Y=6 THEN PRINT ,,A$,,,,A$,,,,A$
190 INPUT N$
200 IF N$=" " THEN GO TO 45
210 STOP
```

Copyrights

WE HAVE all seen program listings with the first line showing who wrote the program or who holds the copyright and, perhaps, wondered how to do it effectively, writes David Bailey of Leeds, West Yorkshire. It is easy enough to make the first line of a program a Rem statement with the appropriate message, but this is far too easy to erase.

So, how about making the message line 0? Try entering line 0. As you cannot do it by normal means — the computer treats it as a direct command — try this: make the first line of your program a Rem statement containing your message less its first character. If the message were going to be Acme Programs, the first line would be

1 REM CME PROGRAMS

Now, as direct commands enter the following:

POKE 16425,0
then
POKE 16426,38.

When the listing is returned to the screen the first line of the program reads

0 ACME PROGRAMS

Now try to erase line 0 in the normal way. If that does not work try to edit it. You cannot do either. Line 0 has no effect on a program providing it does not have a command after the line number. If it has a command after the line number, it will form part of the program and the computer will carry it out.

How was it done? Well, location 16425 in RAM is the first line number so POKEing that with 0 makes the first line number 0. Location 16426 is the command in the first line, so POKEing that location with 38 makes A the first character after the line number.

Super docker

THIS PROGRAM is called Super Docker, writes S Farr of Fareham, Hampshire. It runs on a 1K machine, and has some new features; the cursor controls act as movement indicators, e.g., if you want to go left, you enter 5.

This program has also magnitude, e.g., if you want to go up three lines, you enter 7 — to go up — n/l then 3 n/l and the ship moves three lines. If you continue to press n/l, the ship continues to move up

Long division

```
1   GOTO 350
10  FOR A=1 TO ND
20  LET C=0
30  FOR J=1 TO DD
40  LET E(J)=A(A+DD-J)
50  NEXT J
60  FOR B=1 TO DD
70  LET E(B)=E(B)-B(DD+1-B)
80  IF B=DD THEN GOTO 150
90  FOR F=1 TO DD-B
100 IF E(B-1+F)<0 THEN LET E(B+F)=E(B+F)-1
110 NEXT F
120 FOR F=1 TO DD-B
130 IF E(B-1+F)<0 THEN LET E(B-1+F)=E(B-1+F)+10
140 NEXT F
150 NEXT B
155 IF DD=1 AND E(DD)>-1 THEN GOTO 170
160 IF E(DD)<0 THEN GOTO 200
170 LET C=C+1
175 IF DD=1 AND E(DD)=0 THEN GOTO 250
180 IF E(DD)>0 THEN GOTO 60
200 IF A=ND THEN GOTO 250
210 FOR J=1 TO DD
220 LET A(A+DD-J)=A(A+DD-J)-C*B(DD+1-J)
221 IF A(A+DD-J)<0 THEN LET A(A+DD-J-1)=A(A+DD-J-1)-1
222 IF A(A+DD-J)<0 THEN LET A(A+DD-J)=A(A+DD-J)+10
230 NEXT J
240 LET A(A+1)=A(A+1)+10*A(A)
250 LET D=D+1
260 LET C(D)=C
270 NEXT A
280 FOR D=1 TO ND
285 LET L=C(D)+L
286 IF L=0 THEN GOTO 300
290 PRINT C(D);
300 NEXT D
310 STOP
350 INPUT ND
360 INPUT DD
370 LET D=0
371 LET L=0
400 DIM A(ND+DD-1)
410 DIM B(DD)
420 DIM C(ND)
430 DIM E(DD)
440 PRINT "X ";
450 FOR J=1 TO ND+DD-1
460 IF J<DD THEN LET X=0
470 IF NOT J<DD THEN INPUT X
480 IF NOT J<DD THEN PRINT X;
490 LET A(J)=X
500 NEXT J
510 PRINT " DIVIDED BY Y ";
520 FOR K=1 TO DD
530 INPUT Y
540 PRINT Y;
550 LET B(K)=Y
560 NEXT K
570 PRINT "=";
600 GOTO 10
```

three lines. If you are one line away from the place marked

DDOCK * DOCK

and you are still going three lines up, the ship will crash. To stop it doing that, you have to counteract the three lines up, so you enter: 8 — to go down — n/1 and 2 n/l, you are now travelling one line upwards, because three up — two down = one line up.

At the start of the program, you will be moving at a random velocity so this has to be counteracted. The program is also equipped with fuel. If you go down four lines you lose four fuel units. It also tells you when you have run out of fuel.

Here are some warnings: the ship may not touch the sides of the screen, the bottom of the screen or the top dotted part of the screen.

Criss-cross

THE PROGRAM enables you to play noughts and crosses against a ZX-80 with 1K of RAM, writes Robert Wray of Cottingham, North Humberside. The program does not think more than one move ahead, so if it is not able to block an opponent's line or complete one of its own — the preference is to block the opponent's line — it takes a random move into an unoccupied space.

The computer is always given the first move, by responding to the printout "NL FOR MY GO" by pressing newline, which gives it a reasonable chance of winning. You are then requested to enter the space you wish to take — illegal co-ordinates are rejected — which range from 0, the top-left position, to 8 — at the bottom right.

Thus, if you wish to place your nought — the computer always plays crosses — in the centre, input 4 followed by newline. The program detects the end of the game, and states the winning side or draw and also offers another game obtained by pressing newline.

In the computer, the board positions are stored as the nine elements in the array A. Lines 10 to 42 generate the computer's move using the subroutine at lines 96 to 108 which scan all the lines on the board. Lines 44 to 68 display the board, 70 to 80 watch for the end of the game. Line 82 tests to see if it is the computer's turn — when B is even — otherwise, it continues to lines 86 to 94 which process the player's move. Lines 110 to 130 print out the result of the game and offer another. The lower-case 'a' in lines 56 and 62 represents the graphic character obtained by keying shift A.

Criss-cross

```
2   RANDOMISE
4   DIM A(8)
6   LET B=0
8   PRINT "NL FOR MY GO"
10  INPUT A $
12  LET D=0
14  GOSUB 96
16  FOR C=0TO7
18  IF A(X)+A(Y)+A(Z)=122 THEN GOTO 38
20  IF A(X)+A(Y)+A(Z)=104 THEN IF D=1 THEN GOTO 38
22  IF A(X)+A(Y)+A(Z)=104 THEN LET D=1
24  GOSUB 98
26  NEXT C
28  IF D=1 THEN GOTO 14
30  LET E=RND(9)-1
32  IF NOT A(E)=0 THEN GOTO 30
34  LET A(E)=61
36  GOTO 44
38  IF A(X)=0 THEN LET A(X)=61
40  IF A(Y)=0 THEN LET A(Y)=61
42  IF A(Z)=0 THEN LET A(Z)=61
44  CLS
46  LET B=B+1
48  FOR F=0 TO 8
50  PRINT CHR$(A(F));
52  IF F=8 THEN GOTO 66
54  IF F=2 OR F=5 THEN GOTO 60
56  PRINT "a";
58  NEXT F
60  PRINT
62  PRINT "aaaaa"
64  NEXT F
66  PRINT
68  PRINT
70  GOSUB 96
72  FOR G=0 TO 7
74  IF A(X)=A(Y) AND A(X)=A(Z) AND NOT A(X)=0 THEN GOTO 110
76  GOSUB 98
78  NEXT G
80  IF B=9 THEN GOTO 122
82  IF (B/2)*2=B THEN GOTO 8
84  PRINT "ENTER YOUR GO 0-8"
86  INPUT G
88  IF G>8 THEN GOTO 84
90  IF NOT A(G)=0 THEN GOTO 84
92  LET A(G)=52
94  GOTO 44
96  LET B$="02147685264536048"
98  LET X=CODE(B$)-28
100 LET B$=TL$(B$)
102 LET Y=CODE(B$)-28
104 LET B$=TL$(B$)
106 LET Z=CODE(B$)-28
108 RETURN
110 IF (B/2)*2=B THEN GOTO 116
112 PRINT "I";
114 GOTO 118
116 PRINT "YOU";
118 PRINT "   WIN"
120 GOTO 124
122 PRINT "DRAW"
124 PRINT "NL TO PLAY AGAIN"
126 INPUT C$
128 CLS
130 IFC$=  ""THEN RUN
```

Print statements

I CANNOT recall having seen any comment about the ZX-80 Basic structure Print x, where x is a decimal integer, writes Eric Deeson of Highgate, Birmingham. When the instruction is executed, x is printed.

Thus

```
10 PRINT 3
20 PRINT 2
30 PRINT 1
40 PRINT 0
```

When Run gives

```
3
2
1
0
```

I find the facility of great value during program development, when wishing to do a check Run of an unfinished program. If we use X PRINT X where X is the line number addressed by a Goto or Gosub statement, it is easy to see if the Run is correct. Here is an example.

```
10 PRINT "TYPE   1, 2   OR   3"
20 INPUT A
30 IF A < 1 OR A > 3 THEN GO TO 50
40 GO SUB A * 100
50 PRINT 50
60 STOP
100 PRINT 100
110 STOP
190 RETURN
200 PRINT 200
210 STOP
290 RETURN
300 PRINT 300
310 STOP
390 RETURN
```

When Run, this far-from-complete program will show that intended jumps are executed correctly. In the program, by the way, OR can be typed with a single key-stroke, and stored in a single byte, rather than four. It is worth noting that all the shift keywords — AND, OR, NOT, THEN, TO — can be used in Print statements.

Super docker

```
10 RANDOMISE
20 LET Z=70
30 LET F=10
40 LET W=RND(4) -2
50 LET M=0
50 LET I=RND(4) -2
70 LET V=RND(10)+5
30 LET H=RND(25) +2
90 IF W<-1 OR I<-1 OR I>1 THEN GOTO 120
100 IF V=-1  AND H=14 THEN PRINT "DOCKED"
,,,"SCORE="; Z+(3*F)
110 IF V=-1 AND H=14 THEN STOP
120 IF V<0 OR V>17 OR H<0 OR H>29 THEN
PRINT "CRASHED";
130 IF H=14 AND V<0 THEN PRINT ">TOOFAST>"
140 IF V<0 OR V>17 OR H<0 OR H>29 THEN STOP
150 LET Z=Z-2
160 PRINT "(9shift d's) DOCK (1shift r)>*(
(1shift e) DOCK (10shift f)"
170 IF V<1 THEN GOTO 210
180 FOR Y=1 TO V
190 PRINT
200 NEXT Y
210 IF H<1 THEN GOTO 250
220 FOR X=1 TO H
230 PRINT "STAR";
240 NEXT X
250 PRINT "<0>"
260 IF F<1 THEN GOTO 500
270 PRINT "FUEL =";F;"KG."
280 PRINT "DIRECTION-";
290 INPUT G$
300 PRINT G$
310 IF G$="" THEN GOTO 350
320 PRINT "MAGNITUDE-";
        330 INPUT M
340 IF M<0 THEN GOTO 330
350 CLS
360 IF M>F THEN LET M=F
370 LET V=V+W
380 LET H=H+I
390 IF G$="" THEN LET M=0
400 LET F=F-M
410 IF G$="5" THEN LET H=H-M
420 IF G$="5" THEN LET I=I-M
430 IF G$="6" THEN LET V=V+M
440 IF G$="6" THEN LET W=W+M
450 IF G$="7" THEN LET V=V-M
460 IF G$="7" THEN LET W=W-M
470 IF G$="8" THEN LET H=H+M
480 IF G$="8" THEN LET I=I+M
490 GOTO 90
500 PRINT "NO FUEL",,,,"YOU ONLY HAVE N/L"
510 INPUT G$
520 GOTO 350
```

Space saving

THE INSTR$-Function is a fine space saver, writes Rolf-Fr. Matthaei of Hamburg, West Germany. I am updating my programs from a two-line version of

```
20  A$ = ""
30  A$ = INKEY$: IF A$ = "" THEN 30
```

to a one-line version which saves about 18 bytes:

```
20  A$ = INSTR$(1)
```

I found that INSTR$ also works very well inside expressions:

```
old: 20 A$ = INKEY$:IF A$ = "" THEN 20
        ELSE BX = ASC(A$)
new: 20 BX = ASC(INSTR$(1))
```

The space-saving hint in Tandy Forum, April 1981, is also valid for the TRS-80 Model 1.

Pascal roots

TANDY'S cassette-based Tiny Pascal is an inexpensive but effective way of getting to grips with the Pascal language, but there is an error in the Tiny Pascal manual which can have disconcerting results, writes JE Swann of Henley on Thames, Oxfordshire.

If you run the following program:

```
BEGIN
        WRITE(SQR(4) # )
END.
```

you will obtain the answer 16.

In other words, the SQR(exp) function squares — and does not find square-roots as described in the manual. Of course, Tiny Pascal handles only integer data types so a square-root function has limited application. Here is a Tiny Pascal program which produces integer answers to square-root problems:

```
(*SQUAREROOTS*)
VAR NUMBER,ROOT:INTEGER;
BEGIN
      REPEAT
            READ (NUMBER #. );
             BEGIN
                  ROOT: = 1
                  REPEAT
ROOT: = (NUMBER DIV ROOT + ROOT


ROOT: =(NUMBER DIV ROOT + ROOT)
DIV 2
UNTIL ABS (NUMBER DIV SQR(ROOT)—
1) < 1;
                  WRITE (ROOT #, 13)
             END
      UNTIL NUMBER = 1
END.
```

Little and large

OWNERS of TRS-80s who have recently bought a Radio Shack TRS-80 Line Printer II may be interested to know that the printer, I have found, will produce four character faces, writes David Bishop of Doncaster, South Yorkshire. That is two additional ones to the two mentioned in the printer manual. The two mentioned are normal-size and double-size letters. The other two I have discovered are half-size and bold letters. For a demonstration of the four faces try the following short program:

```
1 LPRINTCHR$(27);CHR$(14)'Double size letters'
2 LPRINTCHR$(27);CHR$(20)'Half size letters'
3 LPRINTCHR$(27);CHR$(14)'Bold letters'
4 LPRINTCHR$(27);CHR$(19)'Normal size letters'
```

```
Double size letters
Half size letters
Bold letters
Normal size letters
```

You will notice that each instruction has to have CHR$(27) followed by CHR$(X), where X is the code number for the face you require. Sadly, however, it is not as simple as this.

What CHR$(X) prints depends on what face was printed last. A normal-size face (CHR$(19)) followed by the instruction CHR$(14) will produce double-size face. However, if the instruction CHR$(14) follows half-size face (CHR$(20)) has been used, bold letters are produced.

If a plain LPRINT or LLIST instruction is executed after double-size face has been used, the printer reverts to normal-size face. If bold face has been used, the printer reverts to half-size face. If normal or half-size faces have been used, the face remains the same.

Finally, printing in double-size or bold face lasts only one line and if your line is too long, some is liable to be lost. Normal and half-size faces wrap around to the next line with no problems — it is possible to LLIST in half-size face, which produces an interesting listing.

Screen draw

THIS program enables the user to draw on the screen using the keypad, writes James Hallows of Solihull, West Midlands. First of all, type the program and after you have successfully used the program to draw graphs, diagrams, etc., start experimenting with it. For example, try adding the following to the program:

```
68 PRINT CHR$(23)
```

Then type the following which enables the computer to draw a diagram at random. It is best to leave out line 68 if the computer is to draw at random.

```
 25 GOTO 325
325 L=INT(RND(1024)):B=L+15360:F=1
330 POKE B,191
332 G=INT(RND(10)):F=F+1
335 IF F=1000 THEN END ELSE 345
345 IF G="1" THEN 200
350 IF G="2" THEN 210
360 IF G="3" THEN 220
370 IF G="4" THEN 230
380 IF G="5" THEN 332
390 IF G="6" THEN 240
400 IF G="7" THEN 250
410 IF G="8" THEN 260
420 IF G="9" THEN 270
430 GOTO 332

10 CLS:PRINT 507,"SKETCHING"
20 FOR N=1 TO 1000:NEXT:CLS
30 PRINT"INSTRUCTIONS (Y/N)?:INPUT A
40 IF A="Y" THEN 280
50 CLS:PRINT"ENTER STARTING POINT (1
TO 1024)":INPUT B
60 X=B+15359:IFX<15360 OR > 16383
THEN 50 :CLS
70 POKE X,191
80 R$=INKEY$:IF R$=""THEN 80
90 IF R$="E" THEN 320 ELSE 100
100 IF R$="C" THEN 50 ELSE 110
110 IF R$="1" THEN 200 ELSE 120
120 IF R$="2" THEN 210 ELSE 130
130 IF R$="3" THEN 220 ELSE 140
140 IF R$="4" THEN 230 ELSE 150
150 IF R$="5" THEN 80 ELSE 160
160 IF R$="6" THEN 240 ELSE 170
170 IF R$="7" THEN 250 ELSE 180
180 IF R$="8" THEN 260 ELSE 190
190 IF R$="9" THEN 270 ELSE 195
195 PRINT R$;:GOTO 80
200 X=X+63:POKE X,191:GOTO 80
210 X=X+64:POKE X,191:GOTO 80
220 X=X+65:POKE X,191:GOTO 80
230 X=X-1:POKE X,191:GOTO 80
240 X=X+1:POKE X,191:GOTO 80
250 X=X-65:POKE X,191:GOTO 80
260 X=X-64:POKE X,191:GOTO 80
270 X=X-63:POKE X,191:GOTO 80
280 CLS:PRINT:PRINT"USE THE KEYPAD
TO DRAW ON THE SCREEN"
290 PRINT "8=UP,2=DOWN,6=RIGHT,
4=LEFT,7=NORTH WEST,9=NORTH EAST,"
300 PRINT "1=SOUTH WEST,3=SOUTH EAST.
PRESS E WHEN YOU HAVE"
303 PRINT "FINISHED DRAWING AND C IF
YOU WANT TO CLEAR THE "
305 PRINT"SCREEN. IF ANY OTHER KEY
IS PRESSED, THEN THE"
307 PRINT"CHARACTER ON THAT KEY WILL
BE PRINTED. KEEP TO"
309 PRINT"THE MIDDLE OF THE SCREEN.
DO NOT TRY TO GO BEYOND"
310 PRINT"THE EDGES OF THE SCREEN.
ENJOY YOURSELF.":GOTO 500
320 CLS:PRINT"ANOHTER GO?":INPUT G:
IF G="Y" THEN 30 ELSE END
500 PRINT:PRINT:PRINT"PRESS ANY KEY."
510 I$=INKEY $:IF I$="" THEN 510
ELSE 50
```

UK101 FRE(X)

ROGER CUTHBERT's excellent discussion of the FRE(X) problem on the UK 101 6502 Special, January 1981, is much appreciated, writes J Ryson of Hyde, Cheshire. I have implemented the suggested change to BAS 3 in the form of a 5V 2716. The modification appears to work perfectly; my general-purpose file program which hung up when sorting large files, now runs correctly thanks to the garbage-clearance routine, and no problem has arisen during two weeks regular use.

I am writing to encourage other UK 101 users to adopt the method. The rest of the article suggested that EPROM implementation was difficult; I believe that this solution is easier than the alternatives suggested and certainly more effective.

The single-voltage 2716 is very easy to program requiring a single 50 millisecond pulse at TTL level for each memory location. If you switch the top three address lines manually, data and other address lines can be controlled by a single PIA device and one of the control lines to provide the program pulse.

I used the extended monitor to move the BAS 3 into RAM, where the necessary bytes were modified and then programmed the EPROM under Basic control through a 6521 PIA.

The method of plugging the EPROM into the BAS 3 socket may be crude, but has two overwhelming advantages: It is easy and it works. Low-profile Texas dil. dockets will plug into a socket. Take a 24-pin socket and bend pins 18, 20 and 21 out horizontally, solder a wire to pin 24 as close under the socket as possible and solder the other end to pin 21 which is Vpp and is thus connected to +5V as is required for read and standby.

Solder a flying lead between pin 18 (ĆE) of the socket and pin 11 of IC 16. Solder another flying lead between pin 20 (OÉ) of the socket and the rear left hand connection of W6 which is situated to the left of IC 17.

Plug this socket — except pins 18, 20 and 21 — into the socket for BAS 3 (IC 11) and then insert the programmed EPROM. To revert to the masked ROM, remove the EPROM and socket and plug in the ROM. No changes have been made to the board.

Same socket

AS A relative newcomer to computing, I found the January 1891 issue extremely enlightening about the use of interrupts as well as useful in eliminating the UK101 Basic3 string, writes R L Curd of Farnborough, Hampshire.

Others interested in Roger Cuthbert's 2716 EPROM replacement may be interested to know the following hardware changes. This will enable the use of the original socket on the board.

PIN 21 goes to plus 5V

PIN 18 goes to ICI6e pin 11 as suggested

PIN 20 goes to IC21b pin 4

I have carried out this modification and it works exceptionally well. Roger Cuthbert is to be congratulated on the clarity of his article.

THE 6502 SPECIAL is dedicated exclusively to the exchange of information between 6502 users. It is up to you, the reader, to help establish this page with your ideas, problems and guidance for other 6502 users. Please mark your letters 6502 Special. We pay £5 for each contribution published.

ASCII characters

FOR HARD-UP Microtan 65 users, this program will type any character by inputting its ASCII code on the Hex keypad writes Bill Crasnell of Churchdown, Gloucestershire.

```
0400   20 FA FD
   3   A501
   5   E930
   7   0A
   8   0A
   9   0A
   A   0A
   B   8550
   D   20 FA FD
0410   A501
   2   E940
   4   100D
   6   A501
   8   E92F
   A   18
   B   6550
   D   2075 FE
0420   4C00 04
   3   18
   5   6909
   7   4C 1A 04
```

Type in Hex ASCII Code

New restore

WHEN THE command New is used on the UK101 one of the many things to happen is that the first link bytes held in memory locations 0301 & 0302 Hex are set to zero, writes Alan Brown of Newbridge, Midlothian. The program is still in memory — it just cannot be listed or run.

If you accidentally New a program, it can be saved as follows:-

```
FOR J= 800 TO 769 STEP -1: IF PEEK (J)<>3 AND PEEK (J+2)<>0 THEN NEXT
```

This should be typed as one line without a line number. When OK is printed J will be the value of the memory location that holds the end (00) of the first program line. If you now type:

```
POKE769,J-769:POKE770,3
```

This will restore the first link bytes. The program can now be listed and should be saved immediately since other program pointers will have been re-set and the system is in danger of crashing. On no account should you try to erase any spurious line numbers which appear — the result can be quite spectacular. The memory locations mentioned are for the new-monitor EPROM and may have to be altered for other monitors.

Screen dump

THIS following machine-language program provides a very convenient means of obtaining a screen dump to printer. It can be used when the machine is in either Basic mode or DOS mode writes LM Goddard.

```
                           ORG  F000H
F000  21 20 F0        LD   HL,F020H
F003  16 4F           LD   D,4FH
F005  1E 00           LD   E,00H
F007  3E 0B    LOOP   LD   A,0BH
F009  43              LD   B,E
F00A  0E 00           LD   C,00H
F00C  CF              RST  8
F00D  3E 13           LD   A,13H
F00F  06 4F           LD   B,4FH
F011  0E 0D           LD   C,0DH
F013  CF              RST  8
F014  1C              INC  E
F015  7B              LD   A,E
F016  D6 18           SUB  18H
F018  C2 07 F0        JP   NZ,LOOP
F018  C9              RET
```

The program is entered most easily using DEBUG, but can, of course, be entered in assembly code and assembled. If using DEBUG to enter the program, use DUMP to store it on disc with start = F000 and END = F01B — Program name, SCRDMP/CMD.

Enter this following program in Basic.

```
100 SYSTEM "LOAD SCRDMP/CMD"
110 DEFUSR = HF000
120 X = USR (0)
130 END
```

Save program with the name SCRDMP/BAS. The utility can be used at any time, as follows:

- Basic mode: enter RUN "SCRDMP/BAS".
- DOS mode: enter SCRDMP/CMD.

Non-printing input

IN THE August 6502 1980 Special, Michael Taylor of Peterborough wrote that the UK 101 or its Ohio Scientific Equivalent could be made to produce a non-printing input instruction, writes M J Murphy of Smallfield, Near Horley, Surrey.

The locations 538 and 539 decimal contain the original UK101 and Ohio Scientific Synmon monitors pointed to FF 69 Hex.

Poking 138 into location 538 caused the vector to point to an RTS machine-code instruction in the monitor. Thus, any output after the Poke was not directed to the screen or printer. I have a CIE which on conversion to 48-by-32 video format required a new monitor. I bought the Mutek Cegmon but was not pleased to find that the machine-code "fix" no longer worked.

The Cegmon output routine is located

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at FF9B not FF69 so that the output veeton now points to FF9B, and must be altered from this value to point to an RTS instruction. The nearest RTS to FF9B is at FFBC, so by altering location 538 to contain the ddecimal equivalent of BC, no output is made to the screen of ACIA.

The original value of location 538 is 9B (Hex), 155 decimal, 188 must be poked in to produce the non-printable input. The routine at FF9B is general-purpose and can be omitted from both keyboard and serial-input routines so that programs may be loaded without being printed on to the screen by preceding the load with a POKE 538, 188. To return to normal printing input POKE 538, 155.

Scroll stopper

MANY UK101 users probably have trouble examining a program while it lists on the screen due to the speed at which it scrolls writes Alan Saul of the Isle of Wight.

Rather than slow all printing with POKE 518, the following routine allows the user to stop scrolling with the space bar and to re-start by pressing any key. That enables a program, or any other listing, to be stopped, or slowed to be viewed at leisure.

To enable the program after RESET/W, re-execute line 70. To disable the routine — it may be necessary for example, if a Basic program polls the keyboard — execute;

```
POKE 538, 105:POKE 539,255
10 FOR I = 546 TO 569
20 READ P:POKE I,P
30 NEXT
40 DATA 201,13,208,17,169,253,141,0
50 DATA 223,173,0,223,201,239,208,3
60 DATA 32,0,253,169,13,76,105,255
70 POKE 538,34:POKE 539,2
80 NEW
```

Cassette data

THIS ROUTINE will generate its own Data statements and output them to a cassette recorder, writes Tim Allen of Ash Vale, Hampshire. The format of the statement is exactly the same as that normally typed by the user, i.e., 100 DATA a,b,c,d,e etc.

It is very important that semicolons are used wherever shown. Data in an array D(A) will need to be changed to PEEK(A) commas. PEEK(512) checks that a line has not been filled.

The main use for the routine is to change lengthy machine-code routines into Basic Data statements, in which case D(A) will need to be changed to PEEK(A) etc. The L in line 70 is used to detect the final piece of data and has the value of the dimension of array D(A) i.e., DIM D(L).

The listing is short and self-explanatory so it can be modified easily to suit individual needs. Do not forget that the Data statements become valid program lines only when the tape is re-loaded and works because of the way in which the UK 101 — and Superboard — save programs.

```
10 REM UK 101 DATA SAVER
20 REM                 INPUT A,Z
30 A=1:Z=10             PEEK
40 POKE 517,1
50 PRINT Z; "DATA";
60 PRINT D(A);:IF PEEK(512)>=240
   THEN 90                      PEEK
70 IFA=L—1 THEN PRINT "," D(A+1):
   POKE 517,0:END
80 PRINT ",";:A=A+1:GOTO 60
90 A=A+1:PRINT "," D(A):Z=Z+5:
   A=A+1:GOTO 50
```

Pay tax

MICHAEL Whittle presents a program which is designed to calculate the pay and tax of monthly-paid staff, and is able to cope with changes in tax code and salary, including calculating back-dated pay rises.

I am not offering it as a business program since it calculates the tax exactly, he writes, whereas the Inland Revenue uses tax tables which undercharge slightly by rounding down the tax due.

The program is written for the UK101, and will run on the Ohio Superboard without modification. It will run on most other micros if lines 120, 130 and 330 and 340 are modified to invite an INPUT at the end of each month's printout.

Line 180 contains the pensions' calculations for the universities superannuations scheme — that would have to be modified for the individuals own pension scheme.

```
10 REM PAYE CALCULATOR by Mike Whittle
20 AP=****:REM ANNUAL SALARY
30 TC=597:REM TAX CODE
40 NI=32.88:REM NATIONAL INSURANCE
50 DEFFNA(X)=INT(X*100+.5)/100
60 DATAAPRIL,MAY,JUNE,JULY,AUGUST,SEPTEMBER
70 DATAOCTOBER,NOVEMBER,DECEMBER,JANUARY
80 DATAFEBRUARY,MARCH,11250,.3,2000,.4,3500
90 DATA.45,5500,.5,5500,.55:REM TAX BANDS
100 DIMM$(12):FORI=1TO12:READM$(I):NEXTI:PRINT
110 FORI=1TO5:READBD(I),RT(I):REM BAND & RATE
120 NEXTI:PRINT"PRESS 'SHIFT' TO CONTINUE -"
130 PRINT"'CONTROL' TO CHANGE VALUES":PRINT
140 FORM=1TO12:PRINTM$(M);":   ";
150 MP=FNA(AP/12)+BP:REM MONTH'S GROSS PAY
160 CG=CG+MP:REM CUMULATIVE GROSS PAY
170 PRINTTAB(12);"GROSS PAY";MP
180 PM=FNA(.0625*(CG-100/12*M)):REM PENSION
190 PX=PM-PP:PP=PM:PRINT"PENS";PX;
200 CP=CG-PM:REM CUMULATIVE TAXABLE PAY
210 TF=(TC*10+9)*M/12:REM TAX FREE ALLOWANCE
220 NT=CP-TF:REM NETT TAXABLE PAY
230 FORI=1TO5:IFNT<=0THEN280
240 TR=BD(I)*M/12:REM TAXABLE AT THIS RATE
250 IFNT<TRTHENTR=NT
260 TT=TR*RT(I):REM TAX AT THIS RATE
270 HI=RT(I):TM=TM+TT:NT=NT-TR:NEXTI
280 TX=FNA(TM-TP):PRINTTAB(15);"TAX";TX;
290 TP=TM:TM=0:PRINTTAB(30);"NAT INS";NI
300 NP=MP-PX-TX-NI
310 PRINTTAB(12);"NETT PAY";NP:BP=0
320 IFM=12THEN470
330 A=PEEK(57088):IFA=255THEN360
340 IFA<>250ANDA<>252THEN330
350 PRINT:NEXTM:END
360 PRINT:INPUT"REVISE SALARY Y/N";Y$
370 IFLEFT$(Y$,1)<>"Y"THEN420
380 INPUT"NEW SALARY";AN
390 INPUT"STARTING MONTH";MN$:FORI=1TOM
400 IFLEFT$(MN$,3)=LEFT$(M$(I),3)THEN450
410 NEXTI:GOTO390
420 INPUT"REVISE TAX CODE Y/N";Y$
430 IFLEFT$(Y$,1)<>"Y"THEN350
440 INPUT"NEW CODE";TC:GOTO350
450 BP=(AN-AP)/12*(M-I+1):REM BACKPAY
460 AP=AN:GOTO420
470 PRINT:PRINT"ANNUAL SUMMARY:":PRINT
480 PRINT"GROSS PAY";CG:PRINT"TAXABLE PAY";CP
490 PRINT"HIGHEST TAX RATE";HI*100;"%"
500 PRINT"TOTAL TAX";TP:PRINT"PENSION";PM:END
```

Memory dump

DATA statement writer, which I have written for the new-ROM Pet will dump any part of memory into data statements as explained in the remark statements, writes SP Folmer of Grantham, Lincolnshire.

When run, the program will ask for the start and end addresses and will then proceed to create the data statements relating to the point of memory selected if insufficient memory has been reserved for the data statements, the error is trapped and a warning message is displayed. There will be data statements present but they will be incomplete.

The Stop key is disabled during execution. The program self-deletes on completion. The logic involved is similar to my Blank Suppression program published in the August 1980 edition of *Practical Computing*.

As not all Pet owners have an assembler, it is desirable to accompany an assembly listing with the correspondence data statements which can be Poked into memory.

Normally, for small programs, this is no great problem. For large programs, however, it is not only extremely tedious but also very error-prone.

This program will do in seconds what would otherwise take hours and might have hidden errors. Another use could be to copy part of the operating system and play with it.

```
10 REM*PRODUCED BY 'DATA STMT WRITER'          (C) S.P.FOLMER, FEB 81*
11 REM
12 REM INTRODUCTION:
13 REM THIS PROGRAM WILL DUMP ANY PART OF MEMORY INTO DATA STATEMENTS.
14 REM THESE DATA STATEMENTS CAN THEN BE SAVED OR APPENDED TO A PROGRAM.
15 REM USING THIS PROGRAM YOU CAN DUMP AN ASSEMBLER PROGRAM AND RELOAD IT
16 REM BY POKING THE DATA BACK INTO MEMORY.
17 REM IT CAN ALSO PROVE A GREAT TIME SAVER FOR ASSEMBLER PROGRAMMERS WHO
18 REM WISH TO PRODUCE LISTINGS OF THEIR PROGRAMS FOR PEOPLE WITHOUT
19 REM ASSEMBLERS.
20 REM
21 REM TO USE:
22 REM THE DATA STATEMENTS WILL APEAR IN THE MEMORY AVAILABLE BEFORE LINE
23 REM 63000. THEREFORE YOU SHOULD FILL AS MUCH MEMORY SPACE BEFORE LINE 63000
24 REM AS YOU THINK THE DATA STATEMENTS WILL REQUIRE.
25 REM YOU CAN DO THIS SIMPLY BY PRECEDING LINE 63000 WITH LONG REM STATEMENTS
26 REM UNDER NORMAL CIRCUMSTANCES THE REM STATEMENTS YOU ARE NOW READING
27 REM SHOULD BE MORE THAN SUFFICIENT, HOWEVER YOU CAN ALWAYS ADD MORE.
28 REM PLEASE NOTE: IT IS IMPORTANT THAT THE FIRST LINE OF THE PROGRAM SHOULD
29 REM BE 63000. CHANGE THIS AT YOUR PERIL!
30 REM THIS PROGRAM WILL SELF-DELETE AFTER COMPLETION, SO ALL THAT WILL REMAIN
31 REM ARE YOUR DATA STATEMENTS.
32 REM
33 REM
63000 REM DATA STATEMENT WRITER (C)               *S.P.FOLMER*FEB 80*
63001 DEFFNA(X)=PEEK(X):DEFFNB(X)=PEEK(X+1):DEFFNC(X)=FNA(X)+256*FNB(X):FI=-1
63002 LP=40
63003 LP=FNC(LP):IF FNC(LP+2)<63000 GOTO 63003
63004 POKE 41,INT(LP/256)
63005 POKE 40,LP-PEEK(41)*256
63006 PRINT"DATA STATEMENT WRITER (C) SPF FEB 81"
63007 INPUT"START ADDRESS (DEC) ";SR
63008 INPUT"END ADDRESS (DEC)   ";EN
63009 POKE 144,49:LN=100
63010 C1=FNC(1025)
63011 OFS=C1+2
63012 FOR I=SR TO EN
63013 IF DS<>0 GOTO 63019
63014 POKE OFS+1,INT(LN/256)
63015 POKE OFS,LN-PEEK(OFS+1)*256
63016 LN=LN+10
63017 OFS=OFS+2
63018 POKE OFS,131:OFS=OFS+1
63019 A$=STR$(PEEK(I)):A$=RIGHT$(A$,LEN(A$)-1)
63020 FOR J=OFS TO OFS+LEN(A$)-1
63021 POKE J,ASC(MID$(A$,J+1-OFS,1))
63022 NEXT J
63023 OFS=J:DS=DS+1
63024 IF OFS>=LP-10 THEN PRINT"*INSUFFICIENT SPACE*":I=EN
63025 IF DS<>20 AND I<>EN THEN POKE OFS,ASC(","):OFS=OFS+1:GOTO 63033
63026 DS=0
63027 POKE OFS,0
63028 OFS=OFS+1
63029 POKE C1+1,INT(OFS/256)
63030 POKE C1,OFS-PEEK(C1+1)*256
63031 C1=OFS
63032 OFS=OFS+2
63033 NEXT I
63034 POKE C1,0:POKE C1+1,0
63035 OFS=C1+2
63036 POKE41,4:POKE40,1
63037 POKE 623,INT(OFS/256)
63038 POKE 42,OFS-PEEK(623)*256
63039 POKE 43,PEEK(623):POKE 144,46
63040 CLR
63041 END
READY.
```

Graphic print

I HAVE a 16K Pet and use it with a standard Teletype or another fast printer, neither of which permit Pet graphics, writes A Walker of St Ives, Huntingdon, Cambridgeshire. However, even with the standard 96-character ASCII set, there are a large number of graphical projects which can be carried out.

To do this it is often necessary, due to the format of the data or the structure of the graphics, to produce the display by Poking characters directly to the screen.

It will operate only with the first 64 screen characters and can be used once a graphics display has been drawn to the screen. It is very simple and merely Peeks at the screen locations and converts the values to ASCII for the printer.

```
1000 REM *** READ & PLOT FROM
     SCREEN TO PRINTER ***
1010 OPEN 1,5,0
1020 P = 32768 : X = 0
1030 FOR I = 0 TO 999
1040 X = X + 1
1050 IF X = 41 THEN X = 1: PRINT #1
1060 C = PEEK(P + 1)
1070 IF C > 0 AND C < 32 THEN C = C +
     64
1080 PRINT # 1, CHR$(C);
1090 NEXT
1100 PRINT # 1:CLOSE 1:RETURN
```

It should be noted that this program as it stands makes no allowance for screen characters with values greater than 63, but inclusions of further conditional statements could be inserted to allow for this.

Zero bugs

WHILE developing a statistical program on the Commodore 8000 series business system, we encountered an interesting problem, write RP Hope and I Powis of the University of Bradford Management Centre. At one point in the program a t-test is calculated on a correlation coefficient. This involves dividing by SRQ(1-Z*Z) where Z is a correlation coefficient. The program was occasionally attempting to divide by zero at this point.

Since the program included a test on Z to bypass the calculation when appropriate — i.e., to avoid the error encountered — considerable head-scratching took place.

Eventually we produced the following short example which illustrates the problem and is self-explanatory. The data used are not invented — they are from our original test data. Also, the occurrence of a nine-digit number subject to the SQR function is not an acceptable explanation of the problem apparent from the contradictory results of statements 20 and 30. The program is consistent over a number of Pets, not just the 8000.

```
10 Z = 248. 11/SQR(61558.5721)
20 IF Z = 1 THEN 50
30 PRINT "Z IS NOT 1 . . . IT IS" Z
40 GO TO 60
50 PRINT "Z IS 1"
60 END
RUN
Z IS NOT 1 . . . IT IS 1
READY
```

Stop-key disable

IT IS often desirable to disable the Stop key, particularly when a program is fully working and the resultant Break and Ready messages interfere with one's screen formats and cursor position, writes AR Browne of Mobberley, Cheshire.

It is quite well known that the statement

POKE 144,49

new-ROM Pets does indeed disable the Stop key, but has the disadvantage that it also stops the timer.

The following subroutines combine to

(continued on next page)

(continued from previous page)

disable the Stop key without stopping the timer and also to re-enable the Stop key if required. The key to the method is Subroutine D, which forms an extension to the Pet clock-interrupt service routine.

It sets the working storage variable at location 155 to indicate that the Stop key has not been pressed — even if it actually has. Subroutine C modifies the stack to force Subroutine D to be executed immediately on exit from the Pet interrupt routine.

Subroutines A and B serve to bring the method into and out of play. To disable the Stop key, invoke Subroutine A, e.g., by Sys (832). To re-enable it invoke Subroutine B, e.g., by Sys (844). Note that it is not the Stop key itself that is disabled/enabled but the break action associated with it.

The subroutines are here shown to reside as usual in the second cassette buffer and may be deposited there by any of the usual means. With suitable modification of address values the subroutines may of course reside elsewhere.

```
Subroutine A

0340    78          SEI
0341    A9 58       LDA #$58
0343    85 90       STA 144
0345    A9 03       LDA #$Ø3
0347    85 91       STA 145
0349    58          CLI
034A    60          RTS
034B    EA          NOP

Subroutine B

034C    78          SEI
034D    A9 2E       LDA #$2E
034F    85 90       STA 144
0351    A9 E6       LDA #$E6
0353    85 91       STA 145
0355    58          CLI
0356    60          RTS
0357    EA          NOP

Subroutine C

0358    A2 04       LDX #4
035A    68          PLA
035B    48          PHA
035C    48          PHA
035D    48          PHA
035E    68          PLA
035F    68          PLA
0360    68          PLA
0361    CA          DEX
0362    D0 F6       BNE -1Ø
0364    A9 03       LDA #$Ø3
0366    48          PHA
0367    A9 74       LDA #$74
0369    48          PHA
036A    BA          TSX
036B    CA          DEX
036C    CA          DEX
036D    CA          DEX
036E    CA          DEX
036F    9A          TXS
0370    4C 2E E6    JMP ISR
0373    EA          NOP

Subroutine D

0374    08          PHP
0375    48          PHA
0376    A5 9B       LDA 155
0378    09 10       ORA #$1Ø
037A    85 9B       STA 155
037C    68          PLA
037D    40          RTI
```

```
                     BYTSVE = $ØØ
                     BRKPNT = $Ø1
                     TMPØ   = $FB
                     RDOC   = $E7EB
                     RDOA   = $E7A7
                     ERROPR = $E7F7
                     USRCMD = $3FA
                     WARM   = $FD56
                        *   = $33A

Ø33A A9 4F           LDA #<BREAKP
Ø33C 8D FA Ø3        STA USRCMD      ; STORE START LO
Ø33F A9 Ø3           LDA #>BREAKP
Ø341 8D FB Ø3        STA USRCMD+1    ; STORE START HI
Ø344 A9 ØØ           LDA # ØØ
Ø346 85 ØØ           STA BYTSVE      ; CLEAR SAVE BYTE
Ø348 85 Ø1           STA BYTSVE+1    ; AND
Ø34A 85 Ø2           STA BYTSVE+2    ; BREAK ADDRESS
Ø34C 4C 56 FD        JMP WARM        ; ENTER MONITOR
Ø34F C9 42    BREAKP CMP #'B'
Ø351 FØ Ø3           BEQ BRKSRV      ; HANDLE BREAK?
Ø353 6C 7B Ø3        JMP(EXTCMD)     ; IF NO,THEN GO
Ø356 AØ ØØ    BRKSRV LDY #$ØØ
Ø358 A5 ØØ           LDA BYTSVE      ; FETCH LAST BYTE
Ø35A 91 Ø1           STA(BRKPNT),Y   ; REPLACE IT
Ø35C 2Ø EB E7        JSR RDOC        ; SKIP DELIMETER
Ø35F 2Ø A7 E7        JSR RDOA        ; GET ADDRESS
Ø362 BØ Ø3           BCS ADDROK
Ø364 4C F7 E7        JMP ERROPR      ; ERROR IF NONE
Ø367 AØ ØØ    ADDROK LDY #$ØØ
Ø369 B1 FB           LDA(TMPØ),Y     ; FETCH TARGET BYTE
Ø36B 85 ØØ           STA BYTSVE      ; SAVE IT
Ø36D A5 FB           LDA TMPØ
Ø36F 85 Ø1           STA BRKPNT      ; SAVE ADDRESS LO
Ø371 A5 FC           LDA TMPØ+1      ; AND
Ø373 85 Ø2           STA BRKPNT+1    ; REPEAT FOR HI
Ø375 98              TYA             ; CLEAR 'A'
Ø376 91 Ø1           STA (BRKPNT),Y; PUT BREAKPOINT
Ø378 4C 56 FD        JMP WARM        ; ENTER MONITOR
Ø37B F7 E7    EXTCMD  .WORD ERROPR
```

Machine-code debug

THIS CONCISE program was developed to simplify the debugging of machine-code routines when using the monitor program Tim, writes N Darlow of Pavenham, Bedfordshire. It allows the placement of a Break instruction, after an instruction of interest, in the program under test. In this manner, the tested program may be executed under user-control and the registers examined or modified after the breakpoint is executed.

The routine also saves and restores the byte overwritten by the break instruction so allowing systematic debugging to be achieved with the minimum of effort. The uncomplicated listing is self-explanatory. Re-location may be accomplished by altering the memory pointers at $033B, $0340, $0354 and $0355 to the appropriate values for a particular memory location area.

After entering the program with either Tim or an assembler, the link to Tim is made with the command .G 033A. This initialises the Tim user-command extension locations and clears variable storage in page zero. The link to Tim should be made after the machine-code load routine has been used, if at all.

The routine is now ready for use and acts as an extension to the monitor command set. For example a typical debugging session may be as follows:

SYS(64785)	
*B PC IRQ ...	
C6FB E62E	Entry from Basic to machine-code monitor
.G 033A	Establish link to Tim, program already loaded
.B 0415	Set a breakpoint at $0415
.G 0400	Execute code up to break-point
*B PC IRQ ...	
0416 E62E	Break entry at $0415 with registers displayed
.B 0430	Set next break-point at $0430, replace last one
.G 0415	Execute from previous break-point to next
*B PC IRQ ...	
0431 E62E	Break entry at $0430 registers available for examination, etc.

As can be seen the routine is very easy to use and saves the need for monotonous cursor manipulation and remembering to replace bytes after inserting break instructions in a program.

Planet path plot

THIS PROGRAM is designed to draw on the screen the paths followed by a number of planets among a number of stars placed on the screen by the user, writes Gareth Ingram of Drayton near Abingdon, Oxfordshire. The starting positions, mass and the velocities of the planets are typed by the user and then the computer moves them step by step across the screen.

This version runs on an Apple II Plus with high-resolution graphics, but because I have no colour, the program plots only in white on black. The insertion of a few colour commands would be simple.

Input routine: The program asks for the number of stars and planets, then a page of instructions follows to show the user the format of input. If you are short of memory, this can be omitted. The user is prompted for the data at the bottom of the screen and then draws up the stars as the co-ordinates are inputted.

However, to save space, no extensive checks are made on this data. There is no means of correcting it so the program must be re-run if an error is made by the user when entering the data. After entering the necessary data, the program returns to the main routine and starts processing.

Three arrays are used to hold all the data; one holds the masses of the objects and the other two hold the co-ordinates and velocities. The velocities are in pairs, one in the horizontal direction and one vertical together giving magnitude and direction.

Now, velocity is change in distance, so the velocities are added constantly to their respective co-ordinates, and the planet appears to move along a straight line as the co-ordinates are incremented constantly by this value.

Computational routine: In the main loop, the effect of gravitational forces between the planets and stars on the planets velocities must be calculated. So that the paths bend under this influence, and the planets do not continue off in a straight line, a change in their velocities is needed.

Change in velocity is acceleration, and the acceleration is then added to the velocities to affect this change. The necessary acceleration can be calculated from Newton's laws of gravitation and motion. Now from Newton's law of gravitation the force, (F), on the planet by a star is given by :

$$F = \frac{\text{Mass of planet X Mass of star}}{\text{separating distance squared}}$$

From this we can calculate the acceleration of the planet, (A), from:

$$A = \frac{\text{Force on planet}}{\text{Mass of planet}}$$

Yet because there are no units, the computational routine does not follow exactly these equations. If it did large jumps off the screen would occur when a planet passes near to a large star. This is not that time-consuming, but there is a force exerted on each planet by every other body and these must all be "averaged" to find the resultant force, and so many calculations are done for each planet in turn. After all of the new velocities have been found in this way, the processing passes on to the next routine.

Plot Routine: The reason why the co-ordinates are updated now and not before is because to plot a line from the old position to the new position, both are needed. So first the old co-ordinates are retrieved and plotted, next the new value is calculated and a line drawn between them thus ensuring that the old co-ordinate is not lost first.

This is done for all of the planets in succession unless a planet is moved out of the screen range. When this happens, the planet is marked "dead" by changing its mass to zero and in future, the two main routines reject and by-pass all zero-mass planets.

Eventually, a point will be reached when all of the planets have exceeded the screen limits or been pulled into endless orbits. So, to stop the program a manual break is needed, since no integral checks are made.

Speed is a prime concern in the program, because of the long slow loops. To keep processing time to a minimum I have made two time-saving measures. Firstly, I replaced all of the constants in the main loops by variables since it takes more time to interpret an ASCII number than to simply retrieve a numerical value.

However, I have still used double-letter named variables which take marginly longer to recognise than single letter names, but the clarity gained in using multi-letter names outweighs any speed advantages. Secondly, I placed the main routines at the head of the program. This is because any GOTOs take less time because the computer looks down the line numbers until it finds the one specified.

As it stands, the program takes into account all the gravitational forces between planets. This can be useful because it makes it possible to examine the movements of large masses moving under each others gravitational influence. Like the search-moon system and binary systems.

The next step with this program is to enable it to work in three-dimensions even though it only plots a two-dimensional view. It is not difficult, and perhaps the stars as well could be made to move.

Variables:

NO	The number of objects
NP	Number of planets
NS	Number of stars
D (NO, 1)	The co-ordinates of objects
V (NP, 1)	Velocities of planets
M (NO)	Masses of objects
DX	Difference in X co-ordinate
DY	Difference in Y co-ordinate
X, Y	The maximum screen limits
L, N	Set to one and nought
AX, AY	Accelerations
I, K	Indexing variables in loops
NA	Intermediate acceleration
R	Power needed in main Computational routine, 1.5

```
10   REM  ------------------
          TRAJECTORY FLOTTER
          ------------------
20   REM
30   REM  ----------------------------
          BY GARETH INGRAM ON APPLE II
          ----------------------------
40   REM
50   REM  --TO SAVE TIME ALL CONSTANTS HAVE
60   REM  --BEEN REPLACED BY VARIABLES    --
70   REM  --AND THE MAIN ROUTINE PLACED  AT
          --THE HEAD OF THE PROGRAM       --
80   GOTO 350
90   REM  ----------------------
          COMPUTATIONAL ROUTINE
          ----------------------
100  FOR I = L TO NP
110  IF M(I) = N THEN 220
120  AX = N:AY = N
130  FOR K = L TO NO
140  IF K = I OR M(K) = N THEN 200
150  DX = D(K,N) - D(I,N)
160  DY = D(K,L) - D(I,L)
170  IF DX = N AND DY = N THEN 200
180  NA = M(K) / (DX * DX + DY * DY)  R
190  AX = AX + DX * NA:AY = AY + DY * NA
200  NEXT
210  D(I,N) = D(I,N) + AX:D(I,L) = D(I,L) +
     AY
220  NEXT
230  REM  -----------------
          PLOT PROJECTILES
          -----------------
240  FOR I = L TO NP
250  IF M(I) = N THEN 320
260  HPLOT D(I,N),D(I,L)
270  D(I,N) = D(I,N) + V(I,N)
280  D(I,L) = D(I,L) + V(I,L)
290  IF D(I,N)< L OR D(I,L)< L THEN M(I) =
     N:GOTO 320
300  IF D(I,N) > X OR D(I,L) > Y THEN M(I) =
     N:GOTO 320
310  HPLOT TO D(I,N),D(I,L)
320  NEXT:GOTO 100
330  REM  ----- END -----
340  REM  ---------------------
          INITIALISE VARIANLES
          ---------------------
350  LOMEM: 16384
360  N = 0:L = 1:I = 0:K = 0
370  AY = 0:AX = 0:NA = 0:NS = 1
380  NO = 1:X = 279:Y = 160
390  DX =1:DY = 1:NP =1:R =1.5
400  REM

          ---------------------
          DISPLAY INSTRUCTIONS
          ---------------------
410  TEXT:HOME:PRINT "------------------------------
     ----------"
420  INPUT "THE NUMBER OF PROJECTILES IS ";
     NP
430  PRINT:PRINT:INPUT"THE NUMBER OF STARS
     IS ";NS
440  NO = NS + NP
450  IF NO  = NS THEN RUN
460  DIM V(NP,L),D(NO,L),M(NO)
470  HOME:PRINT "YOU WILL BE ASKED TO ENTER
     FIVE PARAMETERS"
480  PRINT:PRINT"FIRST THE MASS OF THE OB
     JECT"
490  PRINT:PRINT"SECOND AND THIRD THE COO
     RDINATES OF THE OBJECT"
500  PRINT "THESE START AS (5,5) IN THE TOP"
510  PRINT "LEFT HAND CORNER AND GO TO (275,
     155)"
520  PRINT:PRINT "FOURTH AND FIFTH FOR THE
     PLANETS IS THE VELOCITY IN EACH DIREC
     TION"
530  PRINT:PRINT "FIRST YOU WILL ENTER THE
     DATA FOR THE STARS"
540  PRINT:PRINT "PRESS ANY KEY TO CONTIN
     UE" :GET W$
550  REM  -------------
          INPUT ROUTINE
          -------------
560  HGR:IF NS = N THEN 680
570  FOR I = NP + L TO NO
580  HOME:VTAB 21:PRINT "S" ; I - NP;" ";
590  INPUT "MASS , X , Y"; M(I),DX,DY
600  IF DX< 4 OR DY< 4 OR DX> 276 OR DY>
     160 THEN PRINT "X,Y OUT OF RANGE":
     GOTO 660
610  REM  -------------
          PLOT THE STAR
          -------------
620  HPLOT DX - 2,DY - 1 TO DX - 2,DY + 1
630  HPLOT DX + 2,DY - 1 TO DX + 2,DY + 1
640  HPLOT DX - 1,DY - 2 TO DX + 1,DY - 2
650  HPLOT DX - 1,DY + 2 TO DX + 1,DY + 2
660  D(I,N) = DX:D(I,L) = DY:NEXT
670  REM  -------------
          INPUT ROUTINE
          -------------
680  FOR I = L TO NP
690  HOME:VTAB 21:PRINT "P";I;" ";
700  INPUT "MASS , X , Y"; M(I),D(I,N),
     D(I,L)
710  IF M(I) = N THEN PRINT"MASS IS ZERO:
     ILLEGAL QUANTITY":GOTO 700
720  IF D(I,N)< N OR D(I,L)< N OR D(I,N) > X
     OR D(I,L)> Y THEN PRINT "X,Y OUT OF RA
     NGE":GOTO 700
730  INPUT "VELOCITY IN X,Y "; D(I,N),D(I,L)
740  NEXT
750  REM  ----------------------
          RETURN TO MAIN PROGRAM
          ----------------------
760  GOTO 100
```

ICL workshops

EASTER SUNDAY, people from all the U.K. homed in on Stoke-on-Trent. The reason was the ICL Mouse Workshop. Eddie George of ICL Kidgrove organised two mazes, oscillascopes, EPROM programmers, various components and technical and practical advice. About 40 people and 10 mice, in various states of disarray, attended. Everyone I spoke to enjoyed the day.

One group I was particularly pleased to see was from Hayes Manor School, Middlesex. They all live about five miles from me and I had never heard of them. Later on, I noticed them writing LB Electronics on the cover of their mouse and I asked them if they were being sponsored. They said they went into the LB Electronics shop in Hillingdon and talked to the owner about sponsorship. Apparently, he became enthusiastic and has helped them with money and components. The owner apparently said: "Someone came in last year asking for sponsorship and I turned him down. Then he went and won". That was me. I was trying to talk him into giving me stepper motors.

by Nick Smith

Vernon Gifford — the club co-ordinator of the Amateur Computer Club — was there as an observer. He is trying to organise a one-day seminar on mice/robotics probably at Imperial College in the autumn, and he has also asked me to give a talk to the Croydon ACC on July 7.

Phil Yeardley and I were furiously working on Brainy Bricks and Sterling Mouse respectively. We both went to compete, at the invitation of the organisers, in the first Paris heat at the Sybex exhibition. We suspected that the reason why there were so few working mice in France was because it was so early in the year.

This was largely confirmed by a M. Marquis and his partner who turned up on my doorstep recently. He came to England from France to buy some spare parts for his E-type Jaguar and to see what a real mouse looked like.

Dumb animal

Pete Boyce was there with his "brainless", i.e., microless-mouse. He displayed it going up and down a straight passage. It looks rather like a flying saucer. Round the outside of the mouse are spring-loaded vertical axles, each one pivoted at the top with a wheel which sticks out on the bottom. When the mouse strays, one or more of the wheels hits a wall and is pushed in. A magnet on the axle then operates a reed switch.

One of the ICL mice was gliding up and down in a straight line, too. Apparently it can either solve mazes or move. Both lots of software were written independently and will not work together. This has been made worse by the departure of the main programmer.

Other points noticed was a wheel that looked as if it had been pinched from last year's Swiss mouse, Lami, and a chassis with wheels that could be turned through 90°. Both ideas enable a mouse to go up, down, left and right without turning the chassis.

If you have not yet started building your mouse, you would probably have left with mixed feelings. None of the mice on display showed the slightest indication of rushing off to the centre of the maze in double quick time. So you are not far behind. On the other hand several $10,000 man-hours say it cannot be done without some luck and the occasional prod. Time is beginning to grow short, though to give you some idea, last July I had a chassis with the motors and wheels assembled and it was connected to an output port on my micro. I had also invented my maze-solving algorithm.

Geoff Pike — my partner and mechanic — put the finishing touches to the sensors only three days before the final. I am still trying to improve the sensors. The message is that it is not the building that takes time, it is making it work.

Absolutely everyone has a problem with sensors. Seeing one couple huddled over a pair of Ultra Sonic transducers brought back memories. Another group huddled around an array of eight infra-red detectors. Someone fired a flashgun and all eight sensors detected a wall simultaneously. "They will have to go", said their leader. There really is not a best method which is universally agreed for detecting walls. The only fatal feature in sensors is hysteresis. This effectively eliminates the use of most micro switches.

Do not forget the first British heat at the On-Line Exhibition, Wembley Conference Centre, London, on July 28/31. It is a sad but true fact that the worse the mice the funnier they are so it should be plenty of fun.

Free stepper motors

IMPEX ELECTRICAL — a member of the giant Philips group — has written to me pointing out they it can supply a wide range of new stepper motors from about £13. It can also supply the SAA 1027 stepper motor drive integrated circuit.

Impex would be pleased to hear from anyone interested in stepper-motor applications and is happy to give practical and technical advice if required. In a generous gesture, Impex is prepared to supply a limited number of people building mice, or other novel applications, with free stepper motors. Readers should write, giving details of their application and mentioning the Micro-mouse page to: DS King General Manager, Impex Electrical, Market Road, Richmond, Surrey TW9 4ND.

Les mice à Paris

THE RESULTS of the Micromouse Competition held at the Micro Expo Exhibition in the Palais des Congrès, Paris, were as follows:

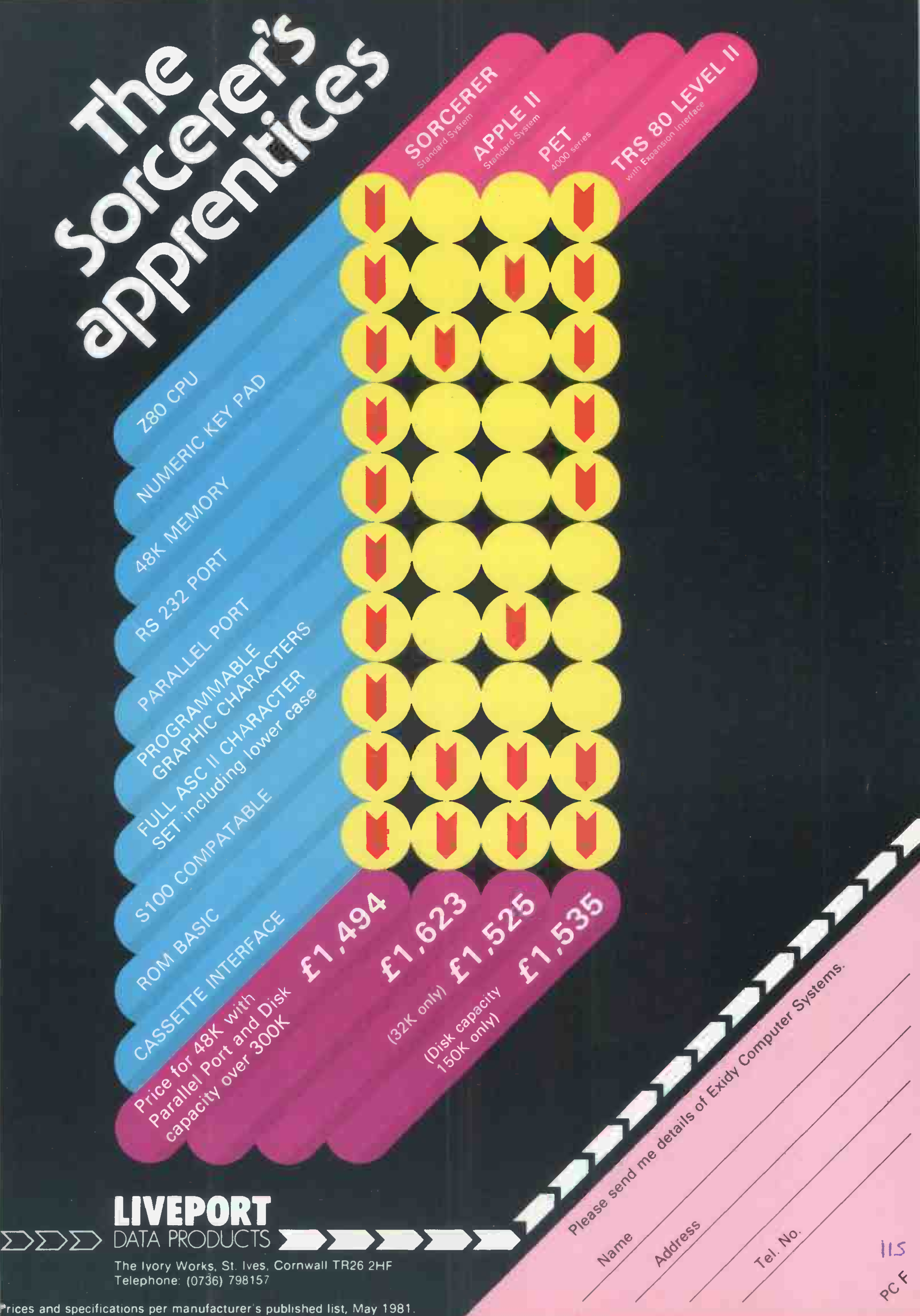
First, Nick Smith with Sterling Mouse, reaching the centre in less than 3½ minutes for which he won a Sharp Computer.

Second, Phil Yeardly with Brainy Bricks. He did not reach the centre but made a splendid effort for which he won a pocket calculator.

In the French Competition: First Kim Mouse which did not reach the centre but made the best effort for which he won an Apple Computer. Second, Carré d'as which only went in a straight line but for its efforts won a Honeywell printer, and third Ariane who, for not much at all won a pocket calculator.

The next contest will be at the Microcomputer Show in the Wembley Conference Centre on July 30 and 31.

Nick Smith with Sterling Mouse.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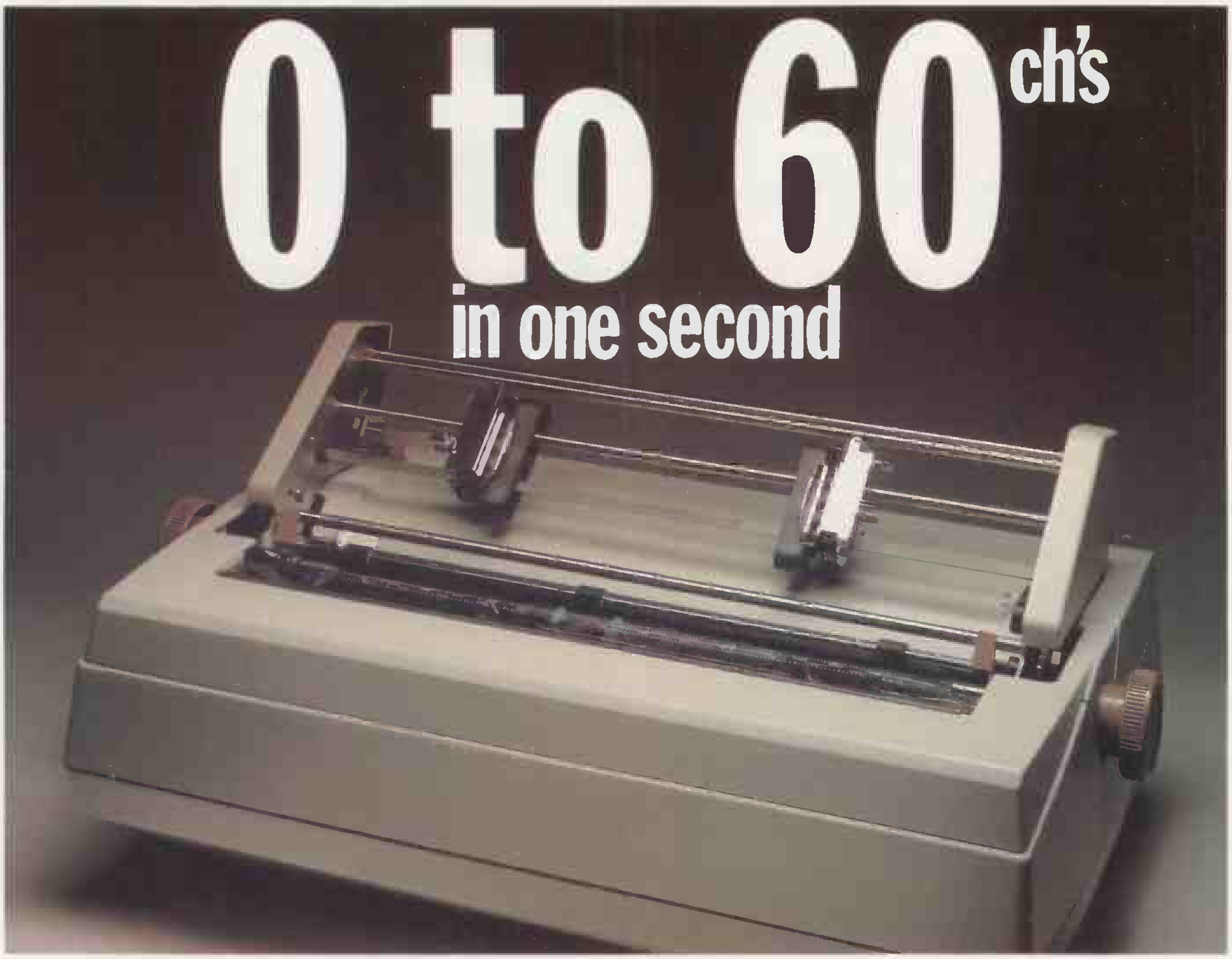

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Programming standard Pascal

By R C Holt and J N P Hume. Published by Prentice Hall International, 380 pages, paperback. Price £7.75; IBSN 0-8359-5690-3. Available from any bookshop.

PASCAL is a high-level programming language which is gaining widespread popularity — especially among microcomputer users and in universities and polytechnics. As an Algol-like language, powerful enough to support most programming applications, yet simple enough that compilers can be implemented for all but the smallest machines, it is deservedly replacing Basic and machine-level languages for more and more tasks.

There is no accepted standard for Pascal. The most widely-quoted standard is the Pascal User Manual and Report by Jensen and Wirth, but that is known to contain defects and ambiguities.

The British Standard Institute proposal to ISO for a new international standard has not yet been agreed. Meanwhile, the UCSD Pascal implementation has become used very widely, and many people regard UCSD as the effective industry standard.

Many universities have decided to teach Pascal because it is easy to teach and to learn, and because it supports the structured programming approach to good programming style.

Excellent example

This new book from Holt and Hume has developed from courses in the computer science department of the university of Toronto — it is an excellent example of a modern, introductory programming language course.

After a brief introduction to computers, the features of Pascal are described in eight chapters, each of which provides a richer, self-contained subset of the full language. Pascal subset one, PS1, is sufficient to write complete programs which print out the results of simple calculations, and each of the subsets which follow, PS2 to PS8, introduces new features, enriching the language and expanding the range of problems which can be solved.

The chapters which describe each language subset are well-illustrated with plentiful examples of complete programs. Each chapter concludes with a detailed summary of the new material and with a number of very good exercises.

The whole approach is designed to start the reader programming in Pascal as early as possible and as much as possible, so that good habits can be formed and reinforced from the beginning.

Between the chapters which introduce new language features are others which contain advice on program design. They teach the techniques which lead to correct programs and which consolidate earlier material. Many examples are concerned with sorting and searching, with manipulation of text and with data structures.

The authors have avoided the trap of regarding Pascal as primarily a language for numerical programming, while providing a valuable short chapter on numerical methods for those who want it.

The final chapters of the book go beyond just teaching programming and Pascal, to provide comparison with PL/1, Fortran 77, Cobol and Algol W, to introduce assembly language programming and machine simulators and to demonstrate the design of a simple compiler. Appendices contain summaries and syntax charts.

The final Pascal subset described, PS8, is less than full Pascal as defined by Jensen and Wirth. The authors have deliberately omitted GOTO statements, sets, variant records, and subprograms as parameters. That is unfortunate — although the ease with which the authors have avoided the need for GOTO should impress many less-disciplined programmers — but the omission is a minor one.

The care which has gone into the order of presentation of Pascal features, the meticulous proof reading, the excellent examples and index all make this a book far above average.

Conclusions

- **It is an excellent introduction to programming and to Pascal, strongly recommended both for newcomers to programming and to experienced programmers who wish to learn Pascal.**

Martyn Thomas

Musical applications of microprocessors

By Hal Chamberlain Hardback 660 pages. £15.80. John Wiley and sons.

THIS substantial volume purports to be a comprehensive guide to one of the more exciting applications of microcomputers, musical synthesis. The book is very much a product of the age in which we live — it seems that everywhere we go that our lives are dominated by both computers and music. In the supermarket, constant musak and microprocessor-controlled tills are the order of the day; pop music plays constantly on the radio where program controllers use desk-top computers to select their playlists — music and computers are everywhere.

Many people do not realise the impact that microprocessors and the new technology have already made on the music we hear. An increasing amount of our music diet is already performed on instruments which employ the latest silicon-chip technology. A large percentage of modern music will have been recorded in studios that employ microprocessors. The latest development is the introduction of digital recording techniques.

Wide subject

The subject is rather a wide one and so to simplify the matter, the book has been split into three sections. The first of the three sections covers the necessary background material, and also provides the reader with an overview of the subject. Chamberlain states that this is a subject which "encompasses the disciplines of physics, mathematics and computer programming", and everything in between.

Chapters included in this section cover such topics as: basic principles, voltage-control methods, and micro-processors. A particularly-interesting part of the first chapter covers the history of electronic sound synthesis.

The first section would stand up as a work in its own right but the real meat of the book is included in the second two sections. Devoted to the twin subjects of computer control of analogue synthesisers and purely digital synthesising techniques, these two sections are a complete course in the subject. The first section must be read or at least glanced at first before proceeding to the next two otherwise an inexperienced reader may find himself in deep water. This is not because of any failing in Hal Chamberlin's excellent book, but has much to do with the fact that there is no point buying expensive hardware if you do not yet know what you want to do with it.

Computer-controlled analogue synthesis is the title of the second section and should be fairly self-explanatory. The section deals with the microcomputer as a controlling device. Since control is the primary use for which microprocessors were developed, it is a relatively-simple section — relative, that is, to the third and final section. This section opens with an evaluation of the elements of analogue synthesis, describing the various elements such as the voltage-controlled oscillator and filters, etc.

Digital synthesis

There is a chapter on digital-to-analogue and analogue-to-digital conversion, another on signal routeing. Again, as in the rest of the book, these chapters are useful in their own right. The rest of this section is devoted to interfacing.

The last section is bigger than the two — almost half the book in fact — and it deals with the digital synthesis of music. Chapters included discuss digital tone — generation techniques, digital filtering techniques, generating percussion sounds, hardware and software. The chapter on software introduces a custom-written language for the generation of music called Notran.

Conclusions

- **This work is an excellent reference book dealing wih an interesting microprocessor application.**
- **Each chapter forms a reference work in its own right.**
- **At slightly less than £16 this book is excellent value as it contains information which could only otherwise be found in a number of other works.**

Bill Bennett

Routines to improve your Pet's display

IN LAST month's article we examined some simple machine-code programs designed to improve the graphics display capability of the Pet. The functions included cursor control which allows the cursor to be moved to specific co-ordinates on the screen where a Print statement will be used to display text or graphics on the line following the cursor position.

The calculation of a screen-momory address from co-ordinate values is essential to any machine-code graphics routine. This is done by a routine common to most of the program in these articles and for this reason is repeated again in listing 1.

This month we look at three more routines, filling a block of the screen with a specified character, reverse-fielding a block of the screen and drawing borders around a specified part of the screen. The program in listing 5 is a Basic loader for all the machine-code routines looked at so far in this series.

Block is a routine which fills a designated block of the screen with a previously-defined character. This is done by a process of repeatedly drawing horizontal lines. The number of lines is equal to the block height and the line length equals block width. The position of the top-left corner of the block is determined by two variables — column number and line number.

Example 1.

```
10 POKE 86,10  : REM START AT COLUMN # 10
20 POKE 87,10  : REM ON LINE # 10
30 POKE 88,8   : REM BLOCK WIDTH 8 CHARACTERS
40 POKE 89,5   : REM BLOCK HEIGHT 5 CHARACTERS
50 POKE 0,42   : REM USE STAR CHARACTERS FOR BLOCK
60 SYS(30470)  : REM CALL SUBROUTINE
```

Example 2.

```
10 POKE 86,10  : REM START AT COLUMN # 10
20 POKE 87,10  : REM ON LINE # 10
30 POKE 88,8   : REM BLOCK WIDTH 8 CHARACTERS
40 POKE 89,5   : REM BLOCK HEIGHT 5 CHARACTERS
50 SYS(30510)  : REM CALL SUBROUTINE
```

Example 3.

```
10 POKE 86,10  : REM TOP LEFT CORNER AT COLUMN # 10
20 POKE 87,5   : REM ON LINE # 5
30 POKE 88,20  : REM BORDER WIDTH 20 CHARACTERS
40 POKE 89,15  : REM BORDER HEIGHT 15 CHARACTERS
50 SYS(30090)  : REM CALL SUBROUTINE
```

The width of the block can be any integer value with a minimum of 1 and a maximum of 255 character spaces. The height of the block can be any integer value with a minimum of 1 and a maximim of 255. In practice, of course, the maximum block size will be the whole screen. A variable allows the character used to fill the block to be defined in the Basic calling program. The variable locations required by the routine are as follows:

86........column number of block start — top left-hand corner.
87..........screen line number of block start — top-left corner.
88......................width of block
89....................height of block.
00........ASCII code value of character used in block.

The routine is called from a Basic program with the command:

SYS(30470)

Some example applications for this function:

- To give background characters in graphics
- To highlight data displayed in block area.
- If the character used is a space, this function can be used to erase blocks of the screen.

Example 1 shows a Basic program which uses this routine. Listing 3 is the reverse field block of screen.

by Nick Hampshire

INVT will reverse the field of all characters within a given block of screen area. This routine is very similar to the routine for filling a block of the screen with a specified character. Instead of putting a character into each memory location in the block, the current contents are read, an exclusive "or" operation performed on it and the result stored in the same location.

The position of the top-left of the block is determined by two variables — column number and line number. The width of the block can be any integer value with a minimum of 1 and a maximum of 255 character spaces. The height of the block can be any integer value with a minimum of 1 and a maximum of 255, though in practice, the maximum size of the reverse-field area is the whole screen. The variable locations required by the routine are as follows:

86......column number of reverse block start top-left corner.
87.........screen line number of reverse block start.
88..........width of reverse block area.
89.........height of reverse block area.

The routine is called from a Basic program with the command:

SYS (30510)

Some example applications for this function:

- To highlight specific sets of data.
- By repeating calling this function with a program loop on the same text area a flashing message can be generated, ideal for error and warning signs.

Example 2 shows a Basic program which uses this routine.

Bord will draw a thin line border around a specified area of the screen. The position of the top-left corner of the border can be any integer value with a minimum of 1 and a maximum of 255 character spaces.

The height of the border can be any integer value with a minimum of 1 and a maximum of 255. In practice, the maximum size of the border is around the outside edge of the screen. The variable locations required by the small routine are as follows:

86.........column number of border start top-left corner.
87.......screen line number of border start.
88..................width of border.
89.................height of border.

The routine is called from a Basic program with the command:

SYS (30090)

Some example applications for this function:

•Enhance the screen appearance by putting a border around the screen edge.
•To identify associated data items by dividing the screen into sub-screen areas using borders to isolate each area.
•To isolate graphical displays from text, etc.

Example 3 is a Basic program which uses routine. All the programs in this series of articles are taken from *Pet graphics* by Nick Hampshire. This book is published by Computabits Ltd price £10.

Listing 1.

```
7400              ;*********************************
7400              ;* ROUTINE TO CALCULATE SCREEN ADDRESS
7400              ;* FROM VALUES FOR COLUMN AND LINE
7400              ;* COLUMN IN $56, LINE IN $57
7400              ;* ADDRESS RETURNED IN $54 AND $55.
7400              ;* THIS ROUTINE IS ONLY CALLED BY OTHER
7400              ;* ROUTINES IN THE PACKAGE, DO NOT
7400              ;* USE BY ITSELF IT WILL CAUSE PET
7400              ;* TO CRASH SINCE REGISTERS ARE NOT
7400              ;* SAVED ON STACK.
7400              ;* ERROR FLAG IN LOCATION $01
7400              ;*********************************
7400              ;
7400  A9 00       ADR1   LDA #$00
7402  85 01              STA T9
7404  A5 56              LDA T3
7406  30 33       ADR2   BMI ERROR1     ;COLUMN < 0 ?
7408  C9 28              CMP #$28
740A  B0 3A              BCS ERROR2     ;COLUMN > 40 ?
740C  A5 57              LDA T4
740E  30 41              BMI ERROR3     ;LINE < 0 ?
7410  C9 19              CMP #$19
7412  B0 48              BCS ERROR4     ;LINE > 25 ?
7414  A9 00              LDA #$00
7416  85 54              STA T1
7418  85 55              STA T2
741A  A5 57              LDA T4
741C  F0 0F              BEQ COLUMN     ;LINE = 0
741E  AA                 TAX
741F  18          LINE   CLC
7420  A5 54              LDA T1
7422  69 28              ADC #$28       ;ADD 40 TO ADDRESS
7424  85 54              STA T1
7426  90 02              BCC LINE2
7428  E6 55              INC T2
742A  CA          LINE2  DEX
742B  D0 F2              BNE LINE       ;ANOTHER LINE ? DO AGAIN
742D  18          COLUMN CLC
742E  A5 54              LDA T1
7430  65 56              ADC T3         ;ADD COLUMN # TO ADDRESS
7432  85 54              STA T1
7434  A5 55              LDA T2
7436  69 80              ADC #$80       ;ADD SCREEN STARTING ADDRESS
7438  85 55              STA T2
743A  60                 RTS
743B              ;
743B              ;
743B              ;
743B  A9 01       ERROR1 LDA #$01       ;SET ERROR FLAG
743D  85 01              STA T9         ;STORE IN 01
743F  A9 00              LDA #$00
7441  85 56              STA T3         ;SET COLUMN TO 0
7443  4C 06 74           JMP ADR2       ;CALCULATE ADDRESS
7446  A9 02       ERROR2 LDA #$02
7448  85 01              STA T9
744A  A9 27              LDA #$27       ;SET COLUMN TO 40
744C  85 56              STA T3
744E  4C 06 74           JMP ADR2
7451  A9 03       ERROR3 LDA #$03
7453  85 01              STA T9
7455  A9 00              LDA #$00       ;SET LINE TO 0
7457  85 57              STA T4
7459  4C 06 74           JMP ADR2
745C  A9 04       ERROR4 LDA #$04
745E  85 01              STA T9
7460  A9 18              LDA #$18       ;SET LINE TO 25
7462  85 57              STA T4
7464  4C 06 74           JMP ADR2
7467
7467
```

Listing 2.

```
7706              ;*********************************
7706              ;* FILL A BLOCK OF THE SCREEN WITH A
7706              ;* SPECIFIED CHARACTER. CHARACTER
```

(continued on next page)

(continued from previous page)

```
7706                ;* STORED IN $00, TOP LEFT COORDINATES
7706                ;* IN $56 (COL) AND $57 (LINE), HEIGHT
7706                ;* OF BLOCK IN $59, WIDTH IN $58
7706                ;* ROUTINE CALLED BY - SYS(30470)
7706                ;*********************************
7706                ;
7706                ;
7706  48            BLOCK   PHA
7707  98                    TYA
7708  48                    PHA
7709  8A                    TXA
770A  48                    PHA
770B  20 00 74              JSR ADR1
770E  A6 59                 LDX T6
7710  A4 58         BLOCK1  LDY T5          ;FILL LINE WITH
7712  88                    DEY             ;CHARACTER
7713  A5 00         BLOCK2  LDA T8
7715  91 54                 STA (T1),Y
7717  88                    DEY
7718  10 F9                 BPL BLOCK2
771A  18                    CLC
771B  A5 54                 LDA T1          ;CALCULATE START OF
771D  69 28                 ADC #$28        ;NEXT LINE
771F  85 54                 STA T1
7721  90 02                 BCC BLOCK3
7723  E6 55                 INC T2
7725  CA            BLOCK3  DEX
7726  D0 E8                 BNE BLOCK1
7728  68                    PLA
7729  AA                    TAX
772A  68                    PLA
772B  A8                    TAY
772C  68                    PLA
772D  60                    RTS
772E
```

Listing 3.

```
772E                ;*********************************
772E                ;* INVERT A BLOCK OF THE SCREEN
772E                ;* TOP LEFT COORDINATES IN $56 (COL)
772E                ;* AND $57 (LINE), HEIGHT OF BLOCK
772E                ;* IN $59, WIDTH IN $58
772E                ;* ROUTINE CALLED BY - SYS(30510)
772E                ;*********************************
772E                ;
772E                ;
772E  48            INVT    PHA
772F  98                    TYA
7730  48                    PHA
7731  8A                    TXA
7732  48                    PHA
7733  20 00 74              JSR ADR1
7736  A6 59                 LDX T6
7738  A4 58         INVT1   LDY T5
773A  88                    DEY
773B  B1 54         INVT2   LDA (T1),Y      ;READ SCREEN CHARACTER
773D  49 80                 EOR #$80        ;INVERT IT
773F  91 54                 STA (T1),Y      ;AND REPLACE ON SCREEN
7741  88                    DEY
7742  10 F7                 BPL INVT2
7744  18                    CLC
7745  A5 54                 LDA T1
7747  69 28                 ADC #$28
7749  85 54                 STA T1
774B  90 02                 BCC INVT3
774D  E6 55                 INC T2
774F  CA            INVT3   DEX
7750  D0 E6                 BNE INVT1
7752  68                    PLA
7753  AA                    TAX
7754  68                    PLA
7755  A8                    TAY
7756  68                    PLA
7757  60                    RTS
7758
```

Listing 4.

```
758A                ;*********************************
758A                ;* DRAW A BORDER OF ANY SIZE AND ANY
758A                ;* LOCATION. TOP LEFT COORDINATES ARE
758A                ;* COLUMN IN $56, AND LINE IN $57
758A                ;* WIDTH IN $58 AND HEIGHT IN $59
758A                ;* ROUTINE CALLED BY - SYS(30090)
758A                ;*********************************
758A                ;
758A                ;
```

```
758A  48          BORD   PHA
758B  98                 TYA
758C  48                 PHA
758D  8A                 TXA
758E  48                 PHA
758F  20 00 74           JSR ADR1       ;TOP LEFT ADDRESS
7592  A5 54              LDA T1         ;SAVE TOP LEFT ADDRESS
7594  85 56              STA T3         ;IN $56 AND $57
7596  A5 55              LDA T2
7598  85 57              STA T4
759A  A9 64              LDA #$64
759C  85 00              STA T8
759E  20 FA 75           JSR HBORD      ;DRAW TOP HORIZONTAL
75A1  18                 CLC
75A2  A5 54              LDA T1         ;FOR VERTICAL LINES
75A4  69 29              ADC #$29       ;TOP ADDRESS = TOP
75A6  85 54              STA T1         ;ADDRESS + 40.
75A8  85 56              STA T3
75AA  A5 55              LDA T2
75AC  69 00              ADC #$00
75AE  85 55              STA T2
75B0  85 57              STA T4
75B2  A9 65              LDA #$65
75B4  85 00              STA T8
75B6  20 04 76           JSR VBORD      ;DRAW LEFT VERTICAL
75B9  18                 CLC
75BA  A5 56              LDA T3         ;TOP VERTICAL ADDRESS
75BC  65 58              ADC T5         ;= TOP VERTICAL + WIDTH
75BE  85 54              STA T1
75C0  C6 54              DEC T1
75C2  A5 57              LDA T4
75C4  69 00              ADC #$00
75C6  85 55              STA T2
75C8  A9 67              LDA #$67
75CA  85 00              STA T8
75CC  20 04 76           JSR VBORD      ;DRAW RIGHT VERTICAL
75CF  A5 56              LDA T3
75D1  85 54              STA T1
75D3  A5 57              LDA T4
75D5  85 55              STA T2
75D7  A6 59              LDX T6         ;BOTTOM LEFT ADDRESS
75D9  C6 54              DEC T1
75DB  CA                 DEX
75DC  CA                 DEX
75DD  18          BORD1  CLC            ;CALCULATED
75DE  A5 54              LDA T1
75E0  69 28              ADC #$28       ;ADD 40 TO ADDRESS
75E2  85 54              STA T1         ;EQUAL TO BOTTOM LEFT
75E4  A5 55              LDA T2
75E6  69 00              ADC #$00
75E8  85 55              STA T2
75EA  CA                 DEX            ;DO AGAIN UNTIL HEIGHT
75EB  D0 F0              BNE BORD1      ;IN X REG =0
75ED  A9 63              LDA #$63
75EF  85 00              STA T8
75F1  20 FA 75           JSR HBORD      ;DRAW BOTTOM HORIZONTAL
75F4  68                 PLA
75F5  AA                 TAX
75F6  68                 PLA
75F7  A8                 TAY
75F8  68                 PLA
75F9  60                 RTS
75FA  A4 58       HBORD  LDY T5         ;LINE LENGTH
75FC  A5 00       HBORD1 LDA T8         ;CHARACTER FOR LINE
75FE  91 54              STA (T1),Y     ;DISPLAY AT ADDRESS,Y
7600  88                 DEY
7601  D0 F9              BNE HBORD1     ;END OF LINE?
7603  60                 RTS
7604  A0 00       VBORD  LDY #$00
7606  A6 59              LDX T6
7608  CA                 DEX
7609  CA                 DEX
760A  A5 00       VBORD1 LDA T8
760C  91 54              STA (T1),Y
760E  18                 CLC
760F  A5 54              LDA T1         ;LOCATION FOR NEXT
7611  69 28              ADC #$28       ;CHARACTER
7613  85 54              STA T1
7615  A5 55              LDA T2
7617  69 00              ADC #$00
7619  85 55              STA T2
761B  CA                 DEX
761C  D0 EC              BNE VBORD1     ;END OF LINE?
761E  60                 RTS
761F
```

Listing 5.

```
10 REM ************************************
20 REM *BASIC LOADER FOR MACHINE CODE
30 REM *GRAPHICS ROUTINES
```

(continued on next page)

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```
40 REM ************************************
100 DATA 31243 : REM CURSOR CONTROL
110 DATA 48,98,48,8A,48
120 DATA A9,13,20,D8,E3,A5,54,F0,09
130 DATA A9,11,20,D8,E3,C6,54,D0,F7
140 DATA A5,55,F0,09,A9,1D,20,D8,E3,C6,55,D0,F7
150 DATA 68,AA,68,A8,68,60
200 DATA 29696
210 DATA A9,00,85,01,A5,56,30,33,C9,28,B0,3A
220 DATA A5,57,30,41,C9,19,B0,48,A9,00,85,54
230 DATA 85,55,A5,57,F0,0F,AA,18,A5,54,69,28
240 DATA 85,54,90,02,E6,55,CA,D0,F2,18,A5,54
250 DATA 65,56,85,54,A5,55,69,80,85,55,60
260 DATA A9,01,85,01,A9,00,85,56,4C,06,74
270 DATA A9,02,85,01,A9,27,85,56,4C,06,74
280 DATA A9,03,85,01,A9,00,85,57,4C,06,74
290 DATA A9,04,85,01,A9,18,85,57,4C,06,74
300 DATA 30029
310 DATA 48,98,58,8A,48,20,00,74,A4,58,A5,00
320 DATA 91,54,88,D0,F9,68,AA,68,A8,68,60
400 DATA 30052
410 DATA 48,98,48,8A,48,20,00,74,A0,00,A6,58
420 DATA A5,00,91,54,18,A5,54,69,28,85,54
430 DATAA5,55,69,00,85,55,CA,D0,EC,68,AA,68
440 DATA A8,68,60
500 DATA 30470
510 DATA 48,98,48,8A,48,20,00,74,A6,59,A4,58,88
520 DATA A5,00,91,54,88,10,F9,18,A5,54,69,28
530 DATA 85,54,90,02,E6,55,CA,D0,E8,68,AA,68
540 DATA A8,68,60
600 DATA 30510
610 DATA 48,98,48,8A,48,20,00,74,A6,59,A4,58,88
620 DATA B1,54,49,80,91,54,88,10,F7,18,A5,54,69,28
630 DATA 85,54,90,02,E6,55,CA,D0,E6,68,AA,68
640 DATA A8,68,60
700 DATA 30090
710 DATA 48,98,48,8A,48,20,00,74,A5,54,85,56
720 DATA A5,55,85,57,A9,64,85,00,20,FA,75,18
730 DATA A5,54,69,29,85,54,85,56,A5,55,69,00
740 DATA 85,55,85,57,A9,65,85,00,20,04,76
750 DATA 18,A5,56,65,58,85,54,C6,54,A5,57,69,00
760 DATA 85,55,A9,67,85,00,20,04,76,A5,56,85,54
770 DATA A5,57,85,55,A6,59,C6,54,CA,CA,18,A5,54
780 DATA 69,28,85,54,A5,55,69,00,85,55,CA,D0,F0
790 DATA A9,63,85,00,20,FA,75,68,AA,68,A8,68,60
800 DATA A4,58,A5,00,91,54,88,D0,F9,60
810 DATA A0,00,A6,59,CA,CA,A5,00,91,54,18,A5,54
820 DATA 69,28,85,54,A5,55,69,00,85,55,CA,D0,EC,60
5000 POKE 48,0:POKE49,112
5010 POKE 52,0:POKE53,112:CLR
9000 DATA*
9010 READL
9020 READA$
9030 C=LEN(A$)
9040 IFA$="*"THEN9140
9050 IFC<1ORC>2THEN9130
9060 A=ASC(A$)-48
9070 B=ASC(RIGHT$(A$,1))-48
9080 N=B+7*(B>9)-(C=2)*(16*(A+7*(A>9)))
9090 IFN<0ORN>255THEN9130
9100 POKEL,N
9110 L=L+1
9120 GOTO9020
9130 IFC=5THENL=VAL(A$):GOTO9020
9140 END
```

How a bubble-sort can test code efficiency

WE HAVE recently been involved at Teesside Polytechnic in software development for a character-recognition project involving the use of a hand-print terminal — see Barker 1981. This device acts as an intelligent peripheral which can be attached to a host mainframe, mini- or microcomputer system. Its mode of operation is such that characters may be printed on a flat, pressure-sensitive writing surface to which an appropriately-designed data-capture document has been attached.

Each character written on the document is recognised and its position deduced. This information is transmitted as a three-byte code to the host computer. The code consists of notional row and column numbers, which reflect the position of the character, and the ASCII value of the character itself.

Algorithm Bubble Sort Records $R_1, \ldots\ldots, R_n$ are rearranged in place; after sorting is complete their keys will be in order $K_1 \leq \ldots\ldots \leq K_n$.

B1. Initialise BOUND Set BOUND ← N.
Bound is the highest index for which the record is not known to be in its final position

B2. Loop on j Set t ← 0. Perform step B3 for j = 1, 2, ..., BOUND-1, and then go to Step B4.

B3 Compare/Exchange $R_j : R_{j+1}$ If $K_j > K_{j+1}$ interchange $R_j \leftarrow R_{j+1}$ and set t ← j.

B4. Any exchanges? If t = 0, the algorithm terminates. Otherwise set BOUND ← t and return to Step B2.

Table 1.

Software in the host computer can be used to validate this data and process it in various ways appropriate to the application. The arrangement of terminal and host computer is shown schematically in figure 1.

Developing applications software in Basic for use in the host computer is straightforward. However, with Basic, the speed with which the user is able to enter data is severely constrained by software. In view of this, we thought it important to be able to develop programs capable of supporting faster real-time response than could be achieved via the Basic interpreter provided with the microcomputer being used, a Commodore Pet — see Commodore 1979.

As both Pascal and assembler programming facilities are available for the Pet, we felt it worthwhile to investigate the relative improvements likely to be gained by re-writing the applications code in one or other of these languages.

To make a comparison of the language systems, we wrote a series of three programs. Each was designed to sort an array of positive integer numbers into

by Philip Barker

order using a bubble-sort technique similar to that described by Knuth. The overall strategy embodied in each program was as follows:

1. Generate 200 random numbers.
2. Initialise a timer.
3. Sort numbers using the bubble-sort.
4. Deactivate the timer.
5. Print out the sort time.

The exact details of program implementation depend on the particular language system employed which will be described later. Fundamental to the comparison is the bubble-sort embedded in the third step of the sequence of operations. For each of the languages used, this was coded directly from Knuth's algorithm which is reproduced in table 1.

For our applications, the records R_1 through R_n correspond to the element positions of the array to be sorted. Similarly, the keys — K_1 through K_n — correspond to the values stored at the different array positions.

The bubble-sort algorithm was implemented in both Basic and Pascal. Listings of the programs are shown in figures 2 and 3. In each case, an array of randomly-selected positive integers is generated by invoking an appropriate function procedure — RND in Basic and Random in Pascal.

Once the array of test values has been generated, the code responsible for performing the sort is timed. Timing is achieved by means of the internal real-time clock of the microcomputer. From Basic, this may be interrogated by

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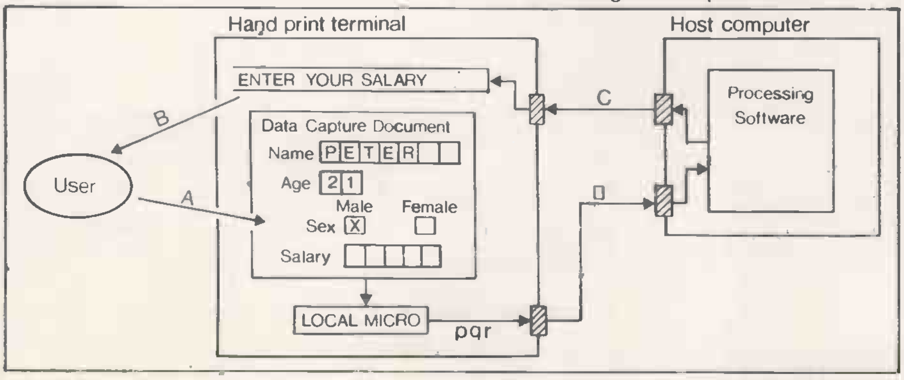
Figure 1. Terminal, host and user interactions in character-recognition experiments.



```
10  DIM X%(200)
20  FOR I = 1 TO 200
30  X%(I) = RND(1)*200
40  NEXT I
50  B = 200  :  KS = TI
60  T = 0
70  FOR J = 1 TO B-1
80  IF X%(J) > X%(J+1) THEN 110
90  Z% = X%(J) : X%(J) = X%(J+1) : X%(J+1) = Z%
100 T = J
110 NEXT J
120 IF T = 0 THEN 140
130 B = T  :  GOTO 60
140 PRINT "TIME";INT((TI-KS)/60); "SECONDS"
```

Figure 2. Bubble-sort in Basic.

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references to the system variable TI. The difference between the values of this variable before and after the sort enables the sorting time to be calculated.

A similar approach is used in the Pascal program: the procedure Settime is used to initialise the real time clock to zero; subsequently, the routines Minutes and Seconds are used to obtain the elapsed time for the sort. Each of the programs was run with sample sizes of 10, 20, 30, 50, 100, 150, and 200 integers. In all cases, the Pascal programs executed far more rapidly than the Basic version. The sort times are presented in figure 8.

To assess the likely improvements gained by using an assembler sort routine, we used a Basic program similar to that shown in figure 4. It acts as a main routine which, after setting up the array to be sorted, invokes an assembly language subroutine whose code is stored at memory locations 6144, decimal address, through 6339. On terminating, the sort routine passes control back to the Basic program which prints out the time required for sorting.

The results of running the program under conditions similar to those used for the high-level languages are presented in figure 8. The substantial improvement in sorting times which results from the use of assembled code is immediately apparent.

To design and implement the assembler version of the routine, you need to understand:

- The way in which the Basic interpreter stores a source program.
- The storage allocation strategy for integer-array variables.
- The hardware architecture of the Pet microcomputer — in particular, its memory structure and the register arrangement of the MCS6502 processor chip.

Details of the first two points are contained in the Pet Users' Manual while the third point is covered in the MOS Microcomputer Family Hardware Manual and other related microcomputer text books.

Within a Basic program, integer arrays are stored in this general format:

array header element 1 element 2 element 3 element n

in a contiguous section of memory. Each

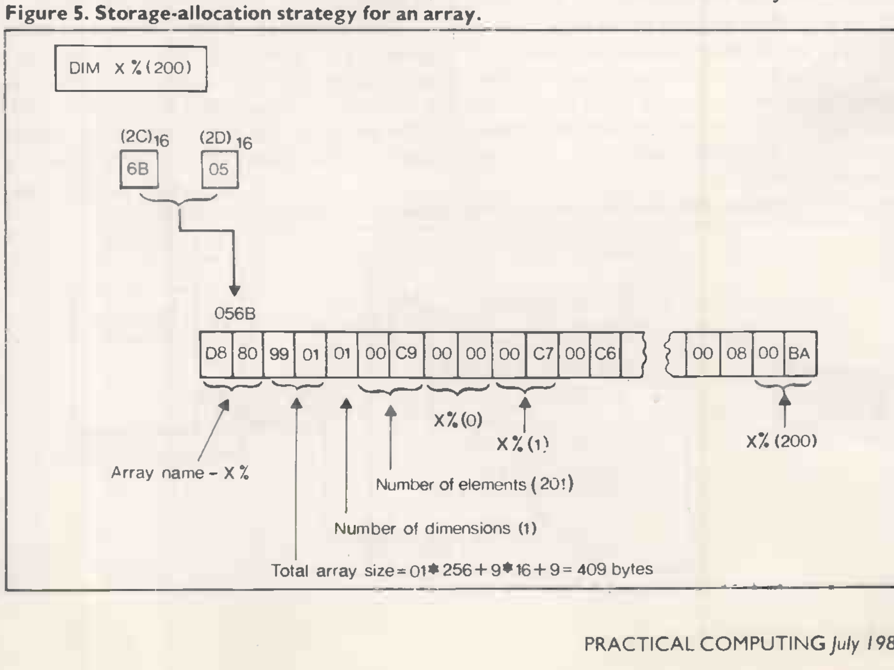
```
VAR  I,J,B,T,Z  :  INTEGER;
            X  :  ARRAY[1..200]OF INTEGER;
BEGIN
  FOR I := 1 TO 200 DO X[I]:= RANDOM;
  B := 200;   SETTIME := (0,0,0);
 REPEAT
    T := 0;
    FOR J := 1 TO B-1 DO
          IF X[J] < X[J+1]
            THEN BEGIN
                   Z := X[J]; X[J]:= X[J+1];
                   X[J+1]:= Z;
                   T := J
                 END;
          B := T
 UNTIL T = 0;
 WRITE('TIME');
 I := MINUTES*60 + SECONDS;
 WRITE(I);
 WRITELN('SECONDS');
 FOR I := 1 TO 200 DO WRITE(X[I])
 END.
```

Figure 3. Bubble-sort in Pascal.

array element, in turn is represented by two adjacent bytes according to the arrangement:

byte →	n	n + 1
	high	low
	element j	

Figure 5. Storage-allocation strategy for an array.



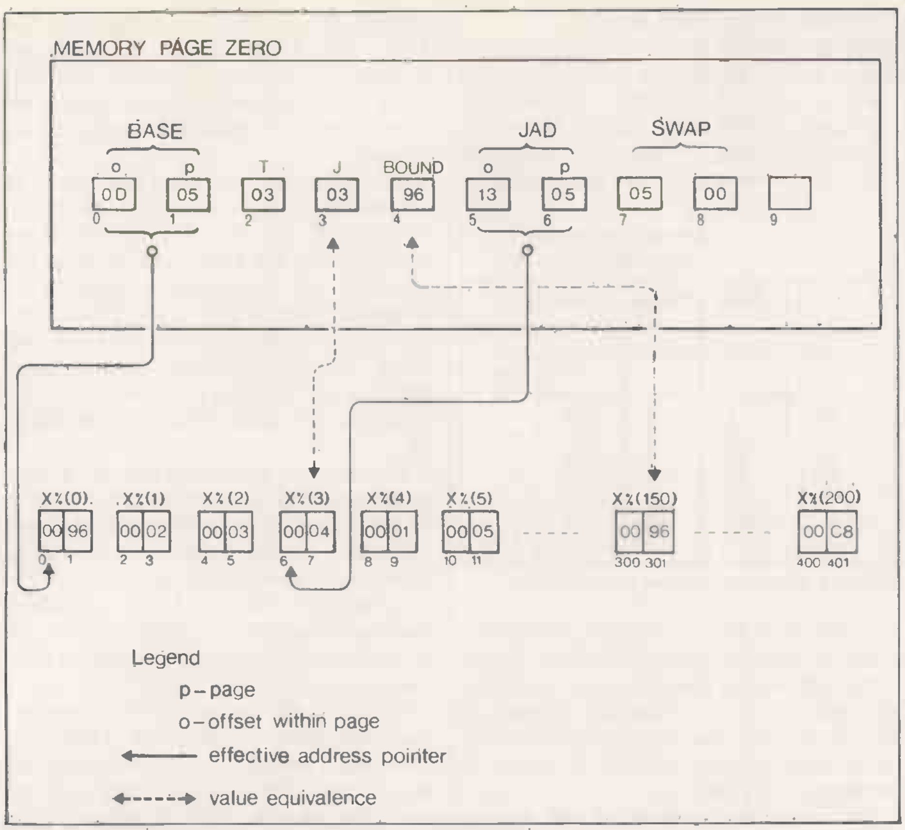


Figure 6. Data structures for the assembler sort routine.

Thus, a value of 1025 decimal would be stored as | 04 | 01 | and a value of 199 would be held in the form | 00 | C7 | . The left-most bit of byte n is used to reflect the sign of the number positive or negative, so that a value such as —522 would be stored as | FD | F6 | . The position at which arrays are stored within the source text of the program is given by the address contained in zero page locations $(45)_{10}$ and $(44)_{10}$.

The former specifies the memory page and the latter the off-set within the page at which the storage for arrays commences. Similarly, zero-page locations $(47)_{10}$ and $(46)_{10}$ point to the section of memory at which array storage ends and unallocated storage commences. These values are useful in helping to decide where to site an assembler routine and the location of the array to be sorted.

The exact details contained in the array header that precedes the elements will depend on its dimension specification. For a one-dimensional array of the type being used for the bubble-sort — see figure 4 — the arrangement is similar to that shown in figure 5. Notice that the array contains a zeroth element which in this program is not used for storing a value to be sorted. Instead, this location functions as a global variable used by the calling routine to pass across to the assembler subroutine the value of the number of elements it is required to sort.

The overall strategy for the machine code sort is:

1. Set up working storage areas.
2. Perform initialisation operations
   2.1 Save zero-page environment of Basic
   2.2 Set base address of array to be sorted
   2.3 Initialise Bound, J and T.
3. Perform the sort
   3.1 Generate the address of array element J
   3.2 Compare elements J and J + 1
      (a) high bytes
      (b) low bytes, if necessary
   3.3 Swap elements J and J + 1, if necessary
      (a) high bytes
      (b) low bytes.
4. Restore the zero-page environment of Basic.
5. Return control to the Basic program.

The working storage areas are locations of memory used by the assembler routine while it is performing the sort. For efficiency, they are located in the first 10 bytes of memory page zero. However, because these locations may have some significance to the Basic interpreter, their contents are transferred to a save area local to the assembler routine. At the end

```
10   DIM  X%(200)
20   FOR I = 1 TO 200
30   X%(I) = RND(1)*200
40   NEXT I
50   FOR I = 1 TO 200 : PRINT X%(I); : NEXT I
60   PRINT " "
70   PRINT PEEK(45) + 256*PEEK(44) + 7
80   PRINT PEEK(47) + 256*PEEK(46)
90   X%(0) = 150  :  KS = TI
100  SYS(6144)   :  REM INVOKE SORT ROUTINE
110  PRINT "TIME"; (TI-KS)/60; " SECONDS"
120  FOR I = 1 TO 200 : PRINT X%(I) : NEXT I
```

Figure 4.

of the sorting operation, these 10 zero-page locations are restored to their original values before passing control to the Basic program. Two subroutines, Saveum and Restor, are used to handle these operations.

The significance of the zero-page

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locations used in the sort are as follows: Swap is the swap area used when the values contained in two consecutive elements of the array are to be interchanged; Bound, T and J perform the same functions as indicated in the bubble-sort algorithm described earlier; JAD is the memory address of the J[th] element of the array and Base is the address of its zeroth element — both in off-set/page format. A sketch showing the relationship between these items and the array to be sorted is presented in figure 6.

Sample Size (N)	Sort times in seconds for programs written in: Basic	Pascal	Assembler	
	random	random	random	worst case
10	1	<1	0.03	0.03
20	4	1	0.07	0.07
30	10	2	0.08	0.12
50	32	7	0.22	0.27
100	124	29	0.78	1.02
150	286	68	1.58	2.25
200	548	116	2.87	4.00

Figure 8. Results of sorting experiments.

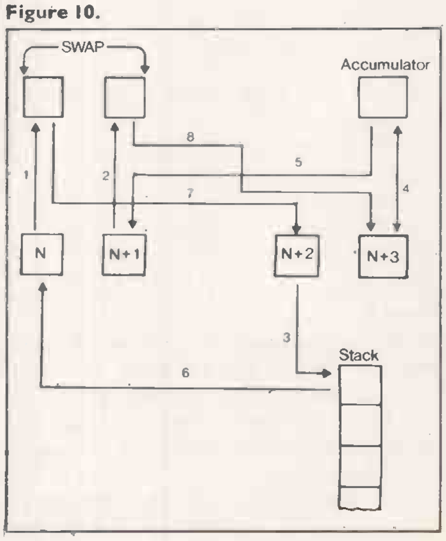
To obtain the address of the zeroth element of the array, the address of the array header — see figure 5 — has to be incremented by 7. However, since the array header may be split over a page boundary this condition has to be checked and the page number incremented accordingly. This situation is illustrated in figure 9.

Once the address of the base location of the array has been computed, it is an easy matter to calculate the address of the first byte allocated to any given element of the array. This is obtained by multiplying the value of J by 2 using an arithmetic shift-level instruction and adding the address of the zeroth element, Base. As usual, care must be taken to check for page-boundary crossings when this addition is performed.

The strategy for performing the comparison is reasonably straightforward once the address of the J[th] element — address N — has been computed. The high-value bytes of the numbers are compared — byte N : byte N+2. If byte N+2 is less than byte N, the numbers are in order and the remaining operations are skipped.

Otherwise, the low-value bytes must be compared — byte N+1 : byte N+3. Depending on the results of these comparisons, the swap code is or is not executed. If the elements need to be swapped, bytes N and N+2 are interchanged along with bytes N+1 and N+3. To achieve this, the zero-page swap area is used. The data flow involved in the swapping operation is illustrated in figure 10.

Figure 10.



The numbers associated with the arrows in figure 10 indicate the order in which data bytes are moved between the registers and other storage locations. This data flow is not intended to be optimal.

A detailed listing of the assembly-language program is shown in figure 7. To produce the machine-code routine, a disc-based, two-pass assembler was used. Given a disc file containing the assembly-language source code, the assembler produced a second disc file containing the object code produced as a result of the assembly process. This object-code file

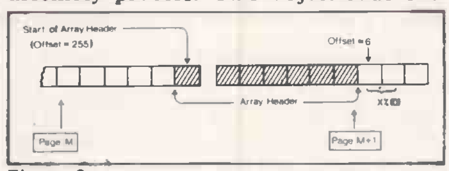


Figure 9.

could be loaded into the Pet memory using the loader program provided with the assembler-development package. Once loaded, the relevant section of memory — $(1800)_{16}$ through $(18C4)_{16}$ — could be dumped on to a cassette tape for subsequent use by means of the Pet terminal interface monitor.

The sorting times observed when different sample sizes are sorted into descending order by programs written in Basic, Pascal and assembler are shown in figure 8. The "random" qualifier indicates that the sort times refer to randomly-generated array elements. For the assembler results, the "worst case" qualifier refers to measurements made using an array of positive consecutive integers — 1 through N — so that the sort routine has to perform the maximum possible number of comparisons and interchanges. The results indicate that Pascal is about four times faster than Basic. Similarly, assembler is between 30 and 200 times faster depending on the sample size.

Although the results in figure 8 indicate the substantially-greater efficiency of the machine-code routine, I must emphasise the limitations of the comparison. In several ways, the conditions under which the experiments were performed favour the machine-code program. In particular:

- The use of positive integers for the tests limits the applicability of the assembler routine.

- It assumes positive values for the array elements and hence does not test the sign bits of the numbers when the high-value bytes of array elements are compared.
- As it is written, the assembler routine could not be used to sort arrays having more than 256 elements.

Neither the Basic nor the Pascal programs suffer from these limitations. However, one of the major attractions of writing programs in assembler language stems from the facilities it provides for taking advantage of special features that cannot be handled in a high-level language — in this case, pre-knowledge of the size and nature of the data set to be sorted. Should the need ever arise, it would be an easy matter to extend the assembler routine to accommodate the limitations outlined — with a consequent increase in sort time.

Additional instructions could be inserted to test the sign bits of the elements compared, with a skip to Noswap if the sign bit of byte N is set and that of byte N + 2 is unset. Alternatively, since negative integers would always sort high in the routine — that is, towards low index values — the routine could be used as it stands with additional code being added to locate any transition between negative and positive element values and, if necessary, implement appropriate block data moves to order the values.

The best strategy would obviously depend on a more detailed analysis of the relevant optimisation calculations. The array size limitation could be overcome by partitioning the array to be sorted into P sub-arrays — each having less than 256 elements — sorting each into order and then performing a P-way merge to produce the final sorted array. Depending on the way in which such extensions are implemented, there would be only minimal departure from the values in figure 8.

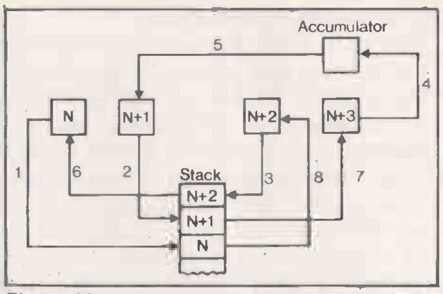


Figure 11.

It is worth making one final point about the assembler program listed in figure 7. The data flow involved in swapping array elements was not optimised in any way to make the element-interchange highly efficient. Greater use of the stack could have been made, thereby removing the need to use two bytes of zero page memory — Swap and Swap + 1. However, it is unlikely that any major improvement in execution time would be observed.

Indeed, the swap code listed in figure 7 — memory locations 1869 through 1888 — requires only 72 machine cycles compared with 76 cycles for equivalent code based on the use of the stack. These observations are confirmed by measurement of the sort times — figures 11 and 12.

Sorting based upon the use of the stack alone — using 200 numbers under worse case conditions — requires 4.08 seconds.

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Figure 12.

```
 Number of                              Assembler Code
 Machine Cycles

                 SWAPUM    NOP
                           LDY #$0
                           LDA  (JAD),Y    ;  LOAD N
        3                  PHA             ;  PUSH ON STACK
        2                  INY             ;  INCREMENT Y REGISTER
        5                  LDA  (JAD),Y    ;  LOAD N+1
        3                  PHA             ;  PUSH ON STACK
        2                  INY             ;  INCREMENT Y REGISTER
        5                  LDA  (JAD),Y    ;  LOAD N+2
        3                  PHA             ;  PUSH ON STACK
        2                  INY             ;  INCREMENT Y REGISTER
        5                  LDA  (JAD),Y    ;  LOAD N+3
        2                  DEY             ;  DECREMENT Y REGISTER
        2                  DEY             ;  DECREMENT Y REGISTER
        5                  STA  (JAD),Y    ;  STORE IN N+1
        2                  DEY             ;  DECREMENT Y REGISTER
        4                  PLA             ;  PULL OFF STACK
        5                  STA  (JAD),Y    ;  STORE IN N
        2                  INY             ;  INCREMENT Y REGISTER
        2                  INY             ;  INCREMENT Y REGISTER
        2                  INY             ;  INCREMENT Y REGISTER
        4                  PLA             ;  PULL OFF STACK
        5                  STA  (JAD),Y    ;  STORE IN N+3
        2                  DEY             ;  DECREMENT Y REGISTER
        4                  PLA             ;  PULL OFF STACK
        5                  STA  (JAD),Y    ;  STORE IN N+2
                           LDA  J          ;  LOAD J VALUE
                           STA  T          ;  STORE IN T
                           NOP
                 NOSWAP    INC  J          ;  INCREMENT J VALUE
     ________
      76 cycles
```

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This value is the average of six measurements for which the standard deviation was 0.005. The corresponding average sorting time based on the use of zero-page memory for swapping was 3.99 seconds with a standard deviation of 0.01. In view of these findings, we conclude that the sort times for the assembler version of the sort routine would be difficult to improve without further detailed analysis based on further optimisation studies.

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Figure 7. Sort routine in assembler.

```
0000                   .OPT MEM
0000  00 00   BASE     .DBYTE $0
0002  00      T        .BYTE $0
0003  00      J        .BYTE $0
0004  00      BOUND    .BYTE $0
0005  00 00   JAD      .DBYTE $0      ; SET UP BASE ADDRESS
0007  00 00   SWAP     .DBYTE $0      ; OF ARRAY
0009                   *=$1800        ; SKIP AROUND DATA
1800  EA      INIT     NOP
1801  EA               NOP
1802  4C 0F 18         JMP GO
1805          SAVE     *=*+10
180F          XPTR     = $2C
180F  20 AC 18 GO      JSR SAVEUM     ;  SAVE ZERO PAGE
1812  A5 2C            LDA $2C
1814  85 00            STA BASE       ; STORE OFFSET
1816  A5 2D            LDA $2D
1818  85 01            STA BASE+1     ; STORE PAGE
181A  A5 00            LDA BASE       ; CHANGE BASE OF
181C  18               CLC            ; ARRAY TO POINT
181D  69 07            ADC #$7        ; TO X%(0)
181F  85 00            STA BASE
1821  90 02            BCC NEXT       ; SEE IF NEW PAGE
1823  E6 01            INC BASE+1     ; INCREASE PAGE NO
1825  EA      NEXT     NOP
1826  A0 08   B1       LDY #$8        ; LOAD OFFSET
1828  B1 2C            LDA (XPTR),Y   ; LOOK IN X%(0)
182A  EA               NOP            ; FOR NUMBER OF ELEMENTS
182B  EA               NOP            ; TO BE SORTED
182C  85 04            STX BOUND      ; INITIALISE BOUND
182E  A9 01   B2       LDA #$1        ;  INITIALISE J
1830  85 03            STA J
1832  A9 00            LDA #$0        ; INITIALISE T
1834  85 02            STA T          ;
1836  EA      B3       NOP
1837  A5 03            LDA J          ; LOAD J VALUE
1839  A4 01            LDY BASE+1     ; GET PAGE
183B  18               CLC
183C  0A               ASL A          ; MULTIPLY BY 2
183D  90 01            BCC SKIP       ; PAGE BOUNDARY?
183F  C8               INY            ; INCREMENT PAGE NUM
1840  18      SKIP     CLC
1841  65 00            ADC BASE       ; ADD IN BASE ADDRESS
1843  90 01            BCC SKIP2      ; PAGE BOUNDARY?
1845  C8               INY
1846  84 06   SKIP2    STY JAD+1
1848  85 05            STA JAD
184A                ;  JAD NOW CONTAINS THE ADDRESS
184A                ;  OF THE REQUIRED ELEMENT
184A                ;
184A                ;  NOW COMPARE ELEMENT J WITH
184A                ;  ELEMENT J+1
184A  EA               NOP
184B  A0 00            LDY #0
184D  B1 05            LDA (JAD),Y    ; TEST FIRST BYTE
184F  C8               INY
1850  C8               INY
1851  D1 05            CMP (JAD),Y    ; COMPARE
1853  90 0F            BCC SWAPUM
1855  F0 02            BEQ EQUAL
1857  B0 36            BCS NOSWAP
1859  88       EQUAL   DEY
185A  B1 05            LDA (JAD),Y    ; TEST SECOND BYTE
185C  C8               INY
185D  C8               INY
185E  D1 05            CMP (JAD),Y    ; COMPARE
1860  F0 2D            BEQ NOSWAP
1862  B0 2B            BCS NOSWAP
1864                ;
1864                ;  NOW  PERFORM THE SWAP
1864                ;
```

```
1864   EA          SWAPUM NOP
1865   A0 00              LDY #0
1867   B1 05              LDA (JAD),Y
1869   85 07              STA SWAP
186B   C8                 INY
186C   B1 05              LDA (JAD),Y
186E   85 08              STA SWAP+1
1870   C8                 INY
1871   B1 05              LDA (JAD),Y
1873   48                 PHA           ; PUSH ONTO STACK
1874   C8                 INY
1875   B1 05              LDA (JAD),Y
1877   88                 DEY
1878   88                 DEY
1879   91 05              STA (JAD),Y
187B   88                 DEY
187C   68                 PLA           ; PULL FROM STACK
187D   91 05              STA (JAD),Y
187F   C8                 INY
1880   C8                 INY
1881   A5 07              LDA SWAP
1883   91 05              STA (JAD),Y
1885   C8                 INY
1886   A5 08              LDA SWAP+1
1888   91 05              STA (JAD),Y
188A   A5 03              LDA J         ; LOAD J VALUE
188C   85 02              STA T         ; STORE IN T
188E   EA                 NOP
188F   E6 03       NOSWAP INC J
1891   EA                 NOP
1892   A5 03              LDA J
1894   C5 04              CMP BOUND
1896   90 9E              BCC B3
1898   F0 03              BEQ B4
189A   4C A7 18           JMP FINISH
189D   A5 02       B4     LDA T
189F   F0 06              BEQ FINISH     ; RETURN IF ZERO
18A1   85 04              STA BOUND
18A3   EA                 NOP
18A4   4C 2E 18           JMP B2
18A7   20 B8 18    FINISH JSR RESTOR     ; RESTORE 0 PAGE
18AA   EA                 NOP
18AB   60                 RTS            ; BACK TO CALLER
18AC                      ;
18AC                      ; SUBROUTINE TO SAVE FIRST TEN
18AC                      ; ZERO PAGE LOCATIONS
18AC   EA          SAVEUM NOP
18AD   A2 09              LDX #$9
18AF   B5 00       SAV01  LDA $0,X
18B1   9D 05 18           STA SAVE,X
18B4   CA                 DEX
18B5   10 F8              BPL SAV01
18B7   60                 RTS
18B8                      ;
18B8                      ; SUBROUTINE TO RESTORE FIRST TEN
18B8                      ; ZERO PAGE LOCATIONS
18B8   EA          RESTOR NOP
18B9   A2 09              LDX #$9
18BB   BD 05 18    RES01  LDA SAVE,X
18BE   95 00              STA $0,X
18C0   CA                 DEX
18C1   10 FB              BPL RES01
18C3   60                 RTS
18C4                      .END

ERRORS = 0000

SYMBOL TABLE

SYMBOL VALUE
B1      1826   B2      182E   B3      1836   BA      189D
BASE    0000   BOUND   0004   EQUAL   1859   FINISH  19A7
GO      180F   INIT    1800   J       0003   JAD     0005
NEXT    1825   NOSWAP  188F   RES01   18BB   RESTOR  18B8
SAV01   18AF   SAVE    1805   SAVEUM  18AC   SKIP    1840
SKIP2   1846   SWAP    0007   SWAPUM  1864   T       0002
XPTR    002C

END OF ASSEMBLY
```

BUYERS' GUIDE

The Buyers' Guide is a summary of low-cost computers available in the U.K. It appears every third month; we add new computers and amend existing information, as required, to keep it up-to-date. Systems are listed by manufacturer.

Microcomputers

ACORN COMPUTERS

Systems 1,2,3: 6502-based, 1-8K RAM, COS or DOS, Hex or full keyboard, TV interface, Acorn bus. Personal or scientific use. Reviewed September 1979. — *From £65 for System 1 kit; £285 for System 2 kit; £670 for System 3 kit*

Atom: 6502, 2-12K RAM, up to 40K external memory, full keyboard, Basic in ROM, high-resolution graphics, cassette and TV interface, parallel port, I/O lines. Should eventually be able to link into a ring. Acorn Computers Ltd, 4a Market Hill, Cambridge CB2 3NJ (0223) 312772. Reviewed November 1980. — *From £130*

AIRAMCO

Mikro 1000: Z-80, 64K RAM, serial and parallel I/O, 12in. P31 display, detachable 117 key keyboard, twin 8in. drives up to 2MB storage, CP/M, S-100. Airamco Ltd, 9 Longford Avenue, Kilwinning Industrial Estate, Kilwinning, Ayrshire. (0294) 57755. — *£3,500*

ALAN PEARMAN LTD

Maple: Z-80A, 16-64K RAM, S-100 bus, CP/M, 8in. discs, RS232 serial and parallel. Sold mainly as Micro-APL system. Alan Pearman Ltd, Maple House, Mortlake Crescent, Chester CH3 5UR. (0244) 46024. — *From £1,510*

ALPHA MICRO

AM-1010, AM-1051: WD-16, 64K-16MB RAM, S-100, four 8in. up to 90MB hard discs, RS232 up to 20 ports. Alpha Micro, 13 Brunswick Place, London N1 6ED. (01) 250 1616. — *From £7,500*

APPLE COMPUTERS

Apple II Plus: 6502, 16-48K RAM, 8K ROM, colour graphics, 5¼in. discs, general use. Own bus. Reviewed October 1979. — *From £695*

Apple III: 6502A with supporting chips, giving it a superset of 6502 instruction set. 96-128K RAM, colour graphics, integral 5¼in., RS232, four 50-pin expansion slots. Microsense, Finway House, Hemel Hempstead, Hertfordshire HP2 7PS. (0442) 48151. — *P.O.A.*

ATTACHE

Attache: 8080, 64K RAM, S-100, parallel port, 8in. discs, business system. Friargrove Systems Ltd, 494 Great West Road, Hounslow, Middlesex (01) 572 3784. — *From £1,737 to £7,000*

BASF

System 7100: Z-80A, 64K RAM, RS232, 5¼in. discs, business systems. MPR, 293 Grays Inn Road, London WC2. (01) 837 6332. — *From £4,937*

BILLINGS

BMS: Z-80A, 64K RAM, 8in. 200MB hard discs, business system. Mitech Data Systems, 8 Guildford Road, Woking, Surrey. (04862) 23131. — *From £4,295*

B L MICROELECTRONICS

Biproc: Z-80 or TMS9980 kit, 1K RAM, 2K monitor, RS232, cassette, TV. BLM, 1 Willow Way, Loudwater, High Wycombe, Buckinghamshire HP11 1JR. (0494) 443073. — *From £150*

BLEASDALE COMPUTER SYSTEMS

UDS: 8080, Z-80, 6809, 32K-1MB, Multibus, CP/M, 5¼in., 8in., hard, RS232, four parallel ports, IEEE 488, development system. Bleasdale Computer Systems, Francis House, Francis Street, London SW1. (01) 828 6661. — *P.O.A.*

BRUTECH ELECTRONICS

BEM: Single-board processor with 6502 and no RAM. Data Precision Equipment, 81 Goldsworth Road, Woking, Surrey GU21 1LJ. (04862) 67420. — *From £133*

BYTRONIX MICROCOMPUTERS

Megamicro: 8080/Z-80, 64K RAM, 8in. discs, CP/M. Business and university use. Bytronix, 83 West Street, Farnham, Surrey GU9 7EN. (0252) 726814. — *From £6,080*

CANON BUSINESS MACHINES

Canon BX-1/BX-1d: 6800, 64K RAM, 5¼in. integral, RS232, V24 ports, business use. Canon Business Machines, Wadden House, Stafford Road, Croydon, Surrey. (01) 680 7700. — *From £3,250*

COMMODORE BUSINESS MACHINES

Pet: 6502, 8-32K RAM, IEEE ports, integral 9in. screen, personal and general use. Reviewed August 1979. — *From £460*

8000 Series — SuperPet: Upgrade of original Pet. 12in. screen, 5¼in. discs, business and general use. Reviewed October 1980. — *From £895*

Kim-1: 6502, LED six-digit display, 1K RAM, cassette and Teletype interface, evaluation board for 6502 chip. Commodore Business Machines, 818 Leigh Road, Slough Industrial Estate, Slough, Berkshire. (75) 74111. Reviewed November 1978. — *From £99.95*

COMPSHOP

UK101: 6502, 4-8K RAM, TV interface, RS232, full keyboard, single-board, personal use, similar to Ohio Superboard. Compshop, 14 Station Road, New Barnet, Hertfordshire EN5 1QW. (01) 441 2922. Reviewed May 1980. — *From £199 for kit*

COMPUCOLOUR

Compucolour II: Z-80, 8-32K RAM, 5¼in. integral discs, 13in. colour VDU, RS232. General use. Dyad Developments. The Priory, Great Milton, Oxfordshire OX9 7PB. (08446) 729. Reviewed June 1979. — *From £998*

Copernicolor II: 8080A, 8-32K RAM, 5¼in., 8in. and Winchesters available, VDU, RS232 bus, standard ASCII keyboard with optional keyboards available, graphics 128 by 128, Basic, assembler, Fortran. Based on Compucolor II, wide range of software. General use. Copernicus Ltd, 7 Wey Hill, Haselmere, Surrey. (0428) 52888. — *From £1,200*

COMPUCORP

655-675: Z-80, 60K RAM own OS but will run CP/M with modifications, RS232, IEEE and others optional. 1-4 5¼in. discs, 16by80 VDU. Business use. Barnet House, 120 High Street, Edgware, Middlesex. (01) 952 7860. — *From £2,595 to £4,750*

COMPUTER CENTRE

Minikit: Z-80, 16K RAM, serial and parallel, 5¼in., CP/M, S-100. *From £800*

Maxikit: Z-80, 16K RAM, serial and parallel, 8in., CP/M S-100. Computer Centre, 9 De la Beche Street, Swansea SA1 3EX. *From £911*

COMPUTERMART LTD

Computermart 2000 range: Z-80A, single/multiple, 16-256K, CP/M, S-100 bus, graphics, 8in. single-density double-sided, 180MB hard disc, general/business use. Computermart, 60 St. Faiths Lane, Norwich, Norfolk. Norwich 615089. *From £6,000*

COMPUTHINK

Act System 800: 6502, 48K RAM, full keyboard, graphics, 5¼ or 8in. discs, 12in. VDU integral. Business system. Act, 66-68 Hagley Road, Edgbaston, Birmingham B16 8PF. (021) 455 8686. Reviewed February 1980. *From £4,000*

CROMEMCO

Single Card Computer: Z-80, S-100, 1K RAM, 20mA/RS232. OEM and industrial use. *From £273*

Z2: Z-80, 31A power supply, motherboard, 21 sockets, serious hobbyist and OEM use. Reviewed February 1979. *From £573*

Z2-H: Z-80A, 64-512K RAM, S-100 bus, CDOS, 10MB formatted fixed disc, two 5¼in. discs, hard discs up to 70MB. *From £5,373*

System 2: Z-80A, 64-512K RAM, S-100 21 slots, CP/M, VDU, two 5¼in. discs, hard discs up to 70MB. Multi-channel interface available. General/business use. *From £2,095 to £6,408 for seven users*

System 3: Z-80A, 64-512K RAM, S-100, CP/M, two or four 8in. discs, hard discs up to 70MB, general/business use. Datron Microcentre, 2 Abbeydale Road, Sheffield S7 1FD. (0742) 585490. Microcentre, 30 Dundas Street, Edinburgh EH3 6JN (031) 556 7354. Comart, PO Box 2, St Neots, Huntingdon, Cambridgeshire PE19 4NY. (0480) 215005. *From £3,568 to £8,304 for seven users*

DATA APPLICATIONS

DAI Personal Computer: 8080, 8-48K RAM, colour graphics, 20 Eurocard industrial interface modules, RS232, industrial use. Data Applications, 168 Dyer Street, Cirencester, Gloucestershire GL7 2PF. (0285) 2588. Reviewed February 1981. *From £998*

DIGITAL DATA ELECTRONICS

SPC/1: 8085, 32-48K RAM, own OS, COMAL, Assembler and Pascal, graphics, up to three 5¼in. drives, up to four 8in. drives, 10MB Winchester, up to four 20MB cartridge, many ports. DDE, Clark House, Pump Lane, Hayes, Middlesex. 01-573 8991. *From £1,995*

DIGITAL MICROSYSTEMS

DSC-3: Z-80, 64K RAM, CP/M, 8in. discs, hard discs up to 28MB, RS232/V24, business and general use. *From £3,445*

DSC-4: Z-80, 128-512K RAM, CP/M, 8in. discs, hard discs up to 28MB, RS232, RS422, business and general use. *From £3,995*

Hex-29: AMD 2900 16-bit, 64K-1,024K RAM, Hex bus, 8in. discs, hard discs up to 28MB. Eight to 32 ports, RS232. Modata, 30 St Johns Road, Tunbridge Wells, Kent TN4 9NT. (0892) 41555. *From £6,445*

DURANGO

F85: 8085, 64K RAM, own bus and OS, graphics, four RS232 ports, integral 9in. VDU, 9 × 9 printer, keyboard and two 5¼in. disc drives. General use. Comp Ancillaries, 64 High Street, Egham, Surrey. (07843) 6455. — *From £7,500*

DYLE HOUSE

System 2000: Z-80, 64K RAM, dual 8in. discs, own OS, business use. Dyle House, 36 Abbot Way, Wellingborough, Northamptonshire. (0933) 79135. — *P.O.A.*

DYNABYTE

Dynabyte 5000: Z-80, 32-64K RAM, S-100, CP/M, MP/M, CP/Net, RS232, 5¼ or 8in. discs, hard discs up to 96MB, expands to multi-task/user system. Business use. Microtech Ltd, Waterloo Road, Uxbridge, Middlesex, UB8 2YW. (0895) 57780. — *From £1,600 to £12,000*

EACA

Video Genie EG3003: Z-80, 16-48K RAM, S-100, CP/M, 5¼in. discs, RS232, personal and general use. Lowe Electronics, Bentley Bridge, Chesterfield Road, Matlock, Derbyshire DE4 5LE. (0629) 2430. Reviewed February 1980. — *From £369*

ECS MICROSYSTEMS INC

Aristocrat: Z-80A, 32-180K RAM, 12K PROM, dual 5¼in. drives, 946K. Three RS232 and one parallel port, CP/M, wide range of protocols, business and general use. Telecomputing Systems Ltd., Seacourt Tower, Westway, Oxford. (0865) 723621. — *From £3,950*

EQUINOX

200: Z-80, 64-512 RAM, S-100 bus, CP/M, Omnix, MicroCobol, MVT FAMOS, cartridge disc, six serial and one parallel port, business use. — *From £7,500*

300: WD-16, 64-256K RAM, S-100 bus, CP/M, Omnix, MicroCobol, MVT FAMOS, cartridge disc drive, six serial ports, business use. Equinox, 16 Anning Street, New Inn Yard, London EC2A 3HB. (01) 729 4460/(01) 739 2387. — *From £10,500*

EUROCALC

Euroc: 8080, 64K RAM, 8in. discs, 15in. VDU, CP/M, business use. Eurocalc, 55/56 High Holborn, London WC1. (01) 405 3113. — *From £8,000*

EXIDY

Sorcerer: Z-80, 16-48K RAM, S-100, RS232, CP/M, 5¼in. discs. Plug-in ROM pack programs. Liveport, The Ivory Works, St Ives, Cornwall TR26 2HF. (0736) 798157. Reviewed May 1979. — *From £749*

GNAT

System 10: Z-80, 65K RAM, own bus, CP/M, graphics, 5¼in. discs, RS232, RS449, 12in. VDU, full keyboard, optional IEEE. Business use. Millbank Computers, 98 Lower Richmond Road, London SW16. (01) 788 1083. Reviewed December 1980. — *From £2,995*

HAYWOOD

Systems 1000-8000: Z-80, 32-65K RAM, 6000 is S-100, 3000 single-board, CP/M, graphics, 5¼in. discs, three serial and parallel ports. Business, scientific and general use. Haywood Electronics Assoc., 11 Station Approach, Northwood, Middlesex. (01) 428 9831. — *From £2,359*

HEATH/ZENITH

H8: Single-board WH8 assembled, 8080, 16K-65K RAM. Heathbus nine slots, cassette interface, nine-digit LED. — *From £321*

Z89: Z-80, 16-48K RAM, CP/M, integral 5¼ in. drive, optional dual external, two RS232, full keyboard, 12in. VDU. — *From £1,570*

WH-11A: LSI-II, 16-bit, 16-32K RAM, own bus and OS, optional dual 8in. drives, serial and parallel ports. Heath Ltd, 11b Bristol Road, Gloucester GL2 6EE. (0452) 29451. (01) 636 7349. — *From £1,250*

HEWART

6800Mk II: 6800 single-board, 1K monitor, 1K user RAM, 1K VDU RAM, 128byte scratchpad, education and home user. S-50 bus. — *From £155*

6800S: 6800, 16K monitor, 8K Basic in ROM, graphics, 5¼in. drive. Hewart, 95 Blakelow Road, Macclesfield, Cheshire. (0625) 22030. — *From £229*

HEWLETT-PACKARD

85A: 16-32K RAM, 32K ROM, IEEE 488, RS232, graphics, 5¼in. drives, integral 32 by 16 VDU, integral thermal printer, QWERTY and numeric keypad. Scientific use. Hewlett-Packard, King Street Lane, Winnersh, Workingham, Berkshire. (0734) 784774. — *From £1,830*

HYTEC MICROSYSTEMS

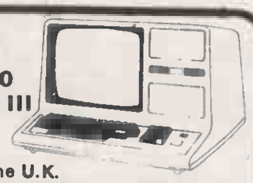
H-3000: Z-80A, 4MHz, 32-128K RAM, two minifloppy discs, standard I/O, two parallel, three serial ports, single board. — *From £2,381-£2,640*

H-4500: Z-80, 64-208K, two minifloppy discs, standard I/O, two parallel, three serial ports, 4MHz option. — *From £3,110*

H-7000: Z-80A, 4MHz, 32-128K, two 8in. floppy discs, standard I/O, two parallel, three serial ports. — *£3,350*

IMAGE DATA PRODUCTS LTD

Image Data Eight: 6802, 4-40K RAM, 43-way bus, own OS, Basic assembler and editor, viewdata-style graphics, up to four 5¼in. discs, up to 12 RS232 ports. Image Data Products, 1-4 Portland Square, Bristol, BS2 8RR (0272) 40248. — *£500-£4,000*



INDUSTRIAL MICROSYSTEMS

Series 5000: Z-80, 16-56K RAM, CP/M, S-100, two or three 5¼in. discs, two serial and one parallel port, desk unit, business and general use. — *From £1,500*

Series 8000: Z-80, 64-256K RAM, S-100, CP/M, MicroCobol, MVT FAMOS, Omnix, two, three or four 8in. disc drives, two serial and one parallel port, desk unit, business and general use. Equinox, 16 Anning Street, New Inn Yard, London EC2A 3HB. (01) 739 2387/(01) 729 4460. — *From £2,500*

INSTAR

Omega: 16-bit, 48-256K RAM, dual floppies, hard discs, up to 12 simultaneous users, business use. — *From £7,500*

Asataxd: Z-80, 16-56K RAM, dual floppies, CP/M, S-100 bus, business use, Instar, 61 High Street, Croydon, Surrey CR0 1QD. (01) 680 5330. — *From £4,950*

INTERTEC

Superbrain: Z-80, 64K RAM, 256 static RAM, dual Shugart, optional hard disc, CP/M, S-100 bus, business and general use. Encotel, Succombs Hill, Upper Warlingham, Surrey. (820) 5701. Sun,138 Chalmers Way, North Feltham Trading Estate, North Feltham, Middlesex. (01) 751 6695. KGB, 88 High Street, Slough, Berkshire. (75) 38581. Icarus Computer Systems Ltd, 27 Greenwood Place, London NW5 1NN. 01-485 5574. Reviewed April 1980. — *From £1,495*

ITHACA INTERSYSTEMS

Pascal Micro DPS1: Z-80, 64K-1MB RAM, full IEEE S-100 bus, CP/M version 2.2, graphics 8in. and hard discs, RS232, four parallel and two serial ports per S-100 board. Ithaca Intersystems, 58 Crouch Hall Road, London N8 8HG. (01) 341 2447. — *From £4,258*

ITT

2020: Built under licence from Apple. See entry under Apple II. ITT, Star House, Mutton Lane, Potters Bar. (77) 51177. — *From £827*

KEMITRON ELECTRONICS

UDS 3000: Z-80, 1-64K RAM, Kbus, own OS, CP/M, 8in. and hard discs, ports up to 256. Kemitron Electronics, (0244) 21817. — *From £640 to £4,000*

LOGABAX

LX-500: Z-80, 32K RAM, S-100, CP/M dual 5¼in. drives, business use. LogAbax Ltd., 1-7 Wesley Avenue, London NW10. (01) 965 0061. — *From £3,000*

LSI COMPUTERS

M-One: 8080, 8-16K RAM, own OS, dual Shugart 8in. drives, two serial and one parallel port, 12in. VDU and full keyboard. Business use. — *From £5,995 with software package*

M-Two: 8085, 64K RAM and 4K EPROM. Launched in December 1980. LSI Computers, Copse Road, St Johns, Woking, Surrey GU21 1SX. (04862) 23411. — *P.O.A.*

LUXOR

ABC 80: Z-80, 16-40K RAM, 12in. VDU, IEEE 488, RS232, 5¼in. drives, loudspeaker, personal and education use. CCS Microsales, 7 The Arcade, Letchworth, Hertfordshire ST6 3ET. (04626) 73301. — *From £795*

MICRO V

Microstar: 8085, 64K RAM, three RS232, serial inputs, StarDOS, twin 8in. drives, general use. Data Efficiency Ltd, Maxted Road, Maylands Avenue, Hemel Hempstead, Hertfordshire. (0442) 63561. — *From £4,950*

MICROMATION

Z-Plus: Z-80, 64K RAM, S-100 bus, CP/M (3), MP/M two serial and six parallel ports, business use. Rostronics, 115-117 Wandsworth High Street, London SW18 4HY. (01) 874 1171. Reviewed May 1980. — *From £3,950 to £8,550*

MICRONEX

MX-100: Z-80A, 64K RAM, S-100 bus, RS232, CP/M, Pixel graphics display system, twin 8in. drives. Micronex, Harford Square, Bristol BS18 8RA. (027) 589 3042. — *From £3,485*

MIDWEST SCIENTIFIC INSTRUMENTS

MSI 6800: 6800, 16K-56K RAM, 5¼ or 8in. or hard discs up to 10MB. Systems 1,2,7 and 10. System 7 runs Flex, MSI, DOS and SDOS, RS232. System 10 is System 7 with hard disc. Business use. Strumech (SEED), Portland House, Coppice Side, Brownhills, Walsall, West Midlands. (279) 4321. Reviewed March 1980. — *From £1,100 to £12,000*

MODULAR BUSINESS SYSTEMS

Tutor: 8085, 32-64K RAM, Intel Multibus, CP/M, optional graphics, twin 5¼in. drives or four 8in., two RS232 serial ports. — *From £2,500*

Elite: 8085, 32-256K RAM, Intel Multibus, CP/M, 5¼in. to 24MB hard discs, RS232, 24-bit TTL programmable port. Modular Business Systems, 21 Chappel Lane, Yeadon, Leeds LS19 7NX. — *From £5,400 to £25,000*

NASCOM

Nascom 1: Z-80, 2-64K RAM, serial and up to 16 parallel ports , 8K Microsoft Basic, 1K monitor in EPROM. Personal use. Reviewed January 1979. — *From £125*

Nascom 2: Z-80, 1K RAM expandable to 256 with Nascom System 80 case. Nasbus, 8K Basic, 2K monitor and 2K character generator, low/high-resolution graphics and colour. 5¼in. single or twin floppy discs, RS232, parallel port, Kansas City cassette port. Nascom Microcomputers, 92 Broad Street, Chesham, Buckinghamshire. (02405) 75151. Reviewed April 1980. — *From £295*

NATIONAL MULTIPLEX

Pegasus: Z-80, 48K RAM, S-100 bus, 5¼in., 8in. drives, CP/M, 12in. VDU, business use. London Computer Store, 43 Grafton Way, London W1. (01) 388 5721. — *From £2,700*

NEWBURY LABORATORIES

7768: CPU board, 4K RAM, cassette and VDU interface, up to 64K RAM, kit only. — *From £45*

NewBrain: Z-80A, 2K static RAM plus 4K static or 16K dynamic, RS232 ports, 16-character, LED display, hand-held. Newbury Laboratories, King Street, Odiham, Hampshire. (025) 671 2910. — *From £155 for model without LED*

NEWTRONICS

Elf II: Single-board on 1802, 256bytes to 64K RAM, Hex keypad, RS232 I/O and VDU interface, option keyboard, machine code or Tiny Basic, educational. — *From £39 for kit*

Explorer 85: 8085, 4-64K RAM, S-100 bus, RS232, VDU interface, 8080 and Z-80 software, hobbyists and OEM use. Newtronics, 255 Archway Road, London N6. (01) 348 3325. — *From £299*

NORTH STAR

Horizon: Z-80A, 16-56K RAM, 5¼in. twin drives, S-100 bus, own OS, business, educational or scientific use. Comart, PO Box 2, St Neots, Huntingdon, Cambridgeshire PE19 4NY. (0480) 215005. Equinox, Kleeman House 16 Anning Street, New Inn Yard, London EC2A 3HB. (01) 729 4460. Reviewed April 1979. — *From £995 to £2,500*

OHIO SCIENTIFIC

Ohio Superboard and Challenger I: 6502, 8K Basic in ROM, 2K monitor, 4K RAM, full keyboard and VDU interface. Hobbyist use. Reviewed June 1979. — *From £160*

Challenger 2: 6502, 48K RAM, dual 8in. drives, serial port, low-cost business use. — *From £1,500*

Challenger 3: 6502, Z-80 and 6800, 48-56K RAM, OSI 48-pin bus, serial port for VDU, CP/M, expands to eight users, 10, 20 and 75MB hard disc, business use. — *From £2,300*

Challenger 4: Similar to Challenger I but 64 by 32 display, colour and sound option. U-Microcomputers, Winstanley Industrial Estate, Long Lane, Warrington, Cheshire WA2 8PR (0925) 54117/8. CTS (0706) 79332. Millbank, 98 Lower Richmond Road, London SW16. (01) 788 1083. Reviewed September 1979. Mutek, Quarry Hill, Bath, Wiltshire. (0225) 743289. — *From £450*

PANASONIC

Panasonic: 8085, 56K RAM, full keyboard, integral 24 by 80 VDU, integral twin 5¼ or 8in. floppy drives. Three RS232, business use. Panasonic Business Systems, 9 Connaught Street, London W2. (01) 261 3121. Reviewed June 1979. — *From £4,150*

PROCESSOR TECHNOLOGY

Sol: 8080, 16K RAM, S-100 bus, 5¼in. drives, VDU integral, business system. Comart, PO Box 2, St Neots, Huntingdon, Cambrideshire PE19 4NY. (0480) 215005. Reviewed July 1979. — *From £1,750*

RAIR

Black Box: 8085, 32-256K RAM, dual mini-floppy discs, eight programmable serial ports, RS232, CP/M, hard discs to 10MB, general and business use. Rair, 30-32 Neal Street, London WC2H 9PS. (01) 836 4663. Reviewed November 1979 and August 1980. — *From £2,300*

RCA

Cosmac: 1802 micro with Hex pad and TV interface. Machine-code programming with Tiny Basic option. **HL** Audio, 255 Archway Road, London N6 5BS. (01) 348 3325.	*From £79 for kit*

RESEARCH MACHINES

380-Z: Z-80, 4-56K RAM, RS232, CP/M, twin 5¼ or 8in. discs, high-resolution graphics. Sold principally to higher and secondary education. Reviewed December 1978.	*From £830 to £3,500*
280-Z: Board version of 380-Z. Research Machines, PO Box 75, Mill Street, Oxford. (0865) 49791.	*From £722 for 4K version*

ROCKWELL

Aim-65: 6502, 1-4K RAM, full keyboard, RS232, discs, hobby use, Portable Microsystems, Forby House, 18 Market Place, Brackley, Northamptonshire NN13 5SF. (0280) 702017. Reviewed July 1979.	*From £250*

SALMON ELECTRONICS

Archives: Z-80 at 4MHz, CP/M, S-100, serial and parallel I/O, 12in. display, 5¼in., 8in. or 19MB hard disc or 8in. Whinchester, 104 keys including 23 configured for Wordstar. Salmon Electronics, PO Box 26, Croft-on-Tees, Darlington (0325) 721368.	*£3,400*

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Databoard 4680: Z-80, 16-64K RAM, own bus, full-colour graphics, 5¼in., 8in. and hard discs up to 10MB, 64 interface units. General use. Microsystems Technology, PO Box 5, Knutsford, Cheshire, WA16 9DU. (0565) 52911.	*P.O.A.*

SD SYSTEMS INC

SBC-100: Z-80, 1-48K, S-100 bus, Basic in 8K ROM, four ROM sockets, optional 5¼in. drives, RS232 serial and parallel, single-board. Reviewed January 1981.	*From £155*
SD-100/200: Z-80, 64-256K RAM, 8K PROM, S-100 bus, RS232, CP/M, 12in. VDU, twin 8in. drives, business, industrial and general use. Airamco, Unit A2, 9 Longford Avenue, Kilwinning Industrial Estate, Kilwinning, Ayrshire KA13 6EX. (0294) 65533. Barcellos, Kimberley House, Vaughan Way, Leicester. (0533) 26584.	*From £3,750*

SEN ELECTRONICS

Organiser: Intel 8085, 64K RAM, multi-user Basic, 8in. drives or 20MB hard discs, three RS232, business use. SEN, 5 London Street, Chertsey, Surrey KT16 8AP. (09328) 66744.	*From £7,500*

SGS-ATES

Nanocomputer: Z-80, 6-64K RAM, Gamma bus, 2K NC-2 monitor in ROM, Basic as option, RS232, cassette interface, Hex keypad. Midwich, Hewitt House, Northgate Street, Bury St Edmonds, Suffolk, IP33 1HQ. Reviewed October 1979.	*From £350*

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DISK PROGRAMS (PET/TRS80): List 50p Grant, 250 Widney Lane, Solihull, W. Midlands.

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Pascal Microengine: MCP1600, executes P-code directly, 64K RAM, own bus, 5¼in., 8in. or hard discs up to 18MB, two RS232, two parallel ports. Pronto Electronics Systems, 466-478 Cranbrook Road, Gants Hill, Ilford, Essex IG2 6LE. (01) 554 6222. *From £2,295*

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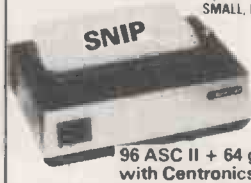

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"Right", said Samson with the ship safely locked on auto-pilot, "all that excitement has given me an appetite. I could eat a horse".

"Horse"? queried Rom. "Please explain".

"It means I'm hungry. I want some food".

"Please explain food".

Samson suspected his leg was being pulled, but he could not detect sarcasm in the cybernoid's even voice. "Food is what gives you energy", he began warily.

"Ah", said Rom, "electricity". He plugged an extension flex into a wall socket and started unrolling it.

"No. No. I mean something to eat, something I can chew, ingest, digest".

"I think he refers to a biochemical process", suggested Ram. "Beings of his type derive their motive power from the breakdown of organic hydrocarbons".

A horrible thought dawned on Samson; "Haven't you got anything edible on the whole ship"?

"Well, Prestel has an Arcturan cuttlefish bone to sharpen his beak", offered Rom.

"And there's a Chinese Takeaway near Delta Parvonis, but we've already passed that", added Ram.

"I'm going to starve", wailed Samson piteously.

"Leave it to me", cut in Prestel. He hopped into his cage and began turning the exercise wheel back and forth, like a thief testing a combination lock. A holographic image of strange shapes and hieroglyphics surrounded him as he did so. He twiddled his wheel some more, working his way through the index pages to the classified refreshment frames. Moments later a red-and-white cardboard box somewhat battered in trasmission, plopped on to the floor of the cage.

"There you are", he said with pride, "Kentucky Fried Klingon. Any subscriber can dial some up, if they know the right number".

"Mm good", said Samson when he finished, licking his fingers appreciatively.

They landed on Blotto, seventh planet of the giant red sun Omega Solaris, three temporal units early amid a hubbub of mutual congratulation. The crew stayed on board to supervise the unloading as the half-baked ideas were pumped out to replenish the dangerously-depleted supply of the Intergalatic Think Tank which had its headquarters on this planet.

That left Samson at a loose end. He had been paid well for his efforts and was now the possessor of a huge wad of Blottonian Gigaflops, but he had no real idea how to spend them With time hanging on his hands he wandered around the amusement arcades, notching up phenomenal scores at Astro-Pinball and raising a few eyebrows by his performance at N-dimensional Hyperchess. He even paid a visit to Blotto's notorious infra-red-light district, but was too timid to sample any of the wares on display, which for a boy of 12 was just as well.

Eventually he mooched back to the ship. "Bored, eh"? was Ram's reaction. "You're set loose in the entertainment centre of the entire galaxy with a fistful of Blottonian Gigaflops and you complain of boredom. I can see I'm going to have to teach you how to enjoy yourself. Just you wait: our unloading will be finished in a few hours. Then we'll really hit the town in style. By the way, where have you been staying"?

"At the YMCA".

"No wonder you're depressed. That crowd of dossers and space hoboes would give anyone the creeps. Listen. I'll tell you what we'll do. First we clean up — then we head straight for the bar at the Intergalactic Hotel. When we've warmed up with a little jungle juice under our belts, we'll take us along to watch the tournament. I bet you don't even know what day it is tommorrow".

Samson confessed his ignorance.

Well, tomorrow's the Vernal Equinox here on Blotto, and tonight's a bit special. Since it takes about 19 of your Earth-years to come round, they grow quite excited about it — kind of carnival atmosphere. At midnight they'll hold the head-butting ceremony. All the young studs in town will climb into the ring and run at each other head-to-head. The winner is the last one left standing. He'll be crowned Spring King".

Samson looked shocked. Ram waved an antenna dismissively.

"It's a vestige of a primitive ritual they had before computerisation. I did it myself one year — got to the semi-final. They called me "battering" Ram. Normally we bring the disposable diapers on the Green Tangerine which they use as padding round their heads, so I guess this time it could get a mite noisy. So long as we arrive in time to catch the quarter-final round we shouldn't miss much of the fun. When it's over things really go wild".

Samson almost imagined a wink on Ram's impassive front panel.

So it was that Samson found himself, only a few hours, standing in a packed crowd of assorted life-forms on the steeply-raked terracing of the Stadium of Light with a half-drunk can of Solarian Punch in one hand shouting enthusiastically at the barbaric spectacle beneath.

Prostrate bodies, felled in earlier rounds, lay littered across the floor of the arena. Two of the survivors were lined up like sprinters at either end of the stadium ready to dash full tilt at one another. This was the needle match. These two were the favourites. At the near end was the local lad, an inhabitant of the neighbouring star system of Altair, who sported a fine pair of antlers and rejoiced in the name of Mighty Micro.

Even at this distance Samson could see that his face was streaked with gashes from earlier bouts. At the far end, built like a tank, was a 40-tonne military cybernoid of the Behemoth class hailing from a planet called Poughkeepsie in the Greater Magellanic Cloud.

The crowd were right behind their own man. Every time the Behemoth moved they hissed, and a great cheer of support erupted into the night when the game Altairan, though dwarfed by his opponent, took off his tracksuit and waved.

A gunshot sounded and the words "They're off" flashed up on the electronic scoreboard. The two gladiators rushed headlong at each other. There was a jarring crunch as skull met steel, distinctly audible above the breathless hush of the spectators. A moment later its echo was drowned by a great roar. Amazingly the skinny Altairan had triumphed: the metal monster keeled over sideways and thudded unconscious to the ground. Samson, carried away by the spring fever, cheered himself hoarse.

The final bout resulted, as expected, in victory for the local hero. He thus won the contest outright and was led to the champion's pedastal from where, dazed and groggy but triumphant, he raised his arms in salute to the crowd — before being borne off shoulder-high into the streets.

Then the festivities really began. In true Blottonian style the frenetic revelry continued unabated till dawn. The roadways were full of dancers and there were wild goings-on as an incredible variety of different beings drowned their inhibitions in the fire-water for which Blotto was justly famous.

Samson's recollection of the subsequent events of that night was very hazy. Suffice it to say that he woke up with a very thick head in a sidestreet of the Blottonian capital. His money was all gone. He never found out whether he had lost it, spent it or simply had his pocket picked. Next to him in the gutter lay his Binary Tree. Its pot was smashed but some soil still clung to its roots.

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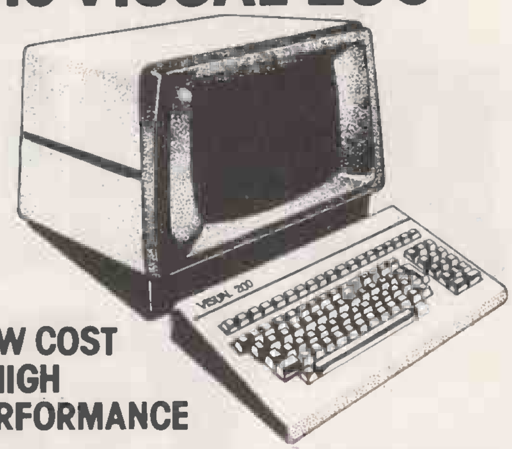

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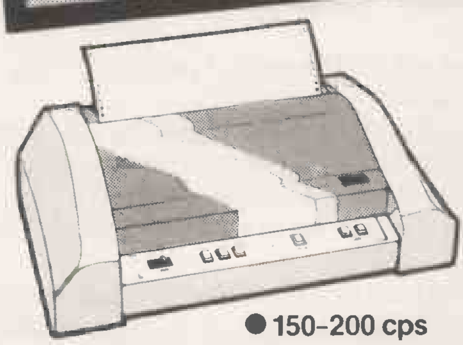

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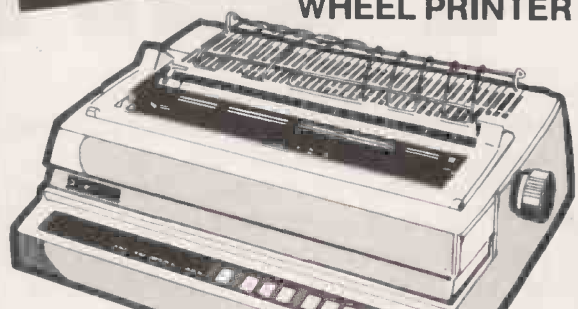

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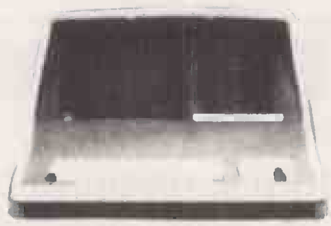

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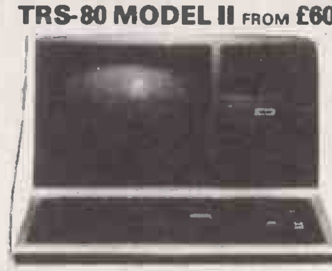

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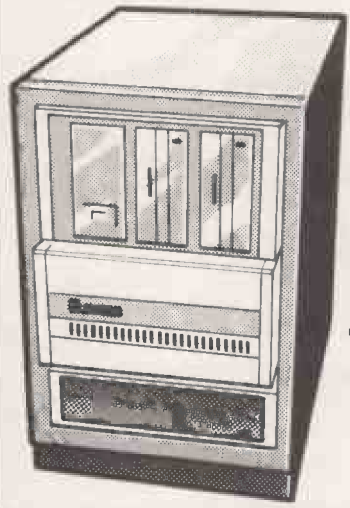

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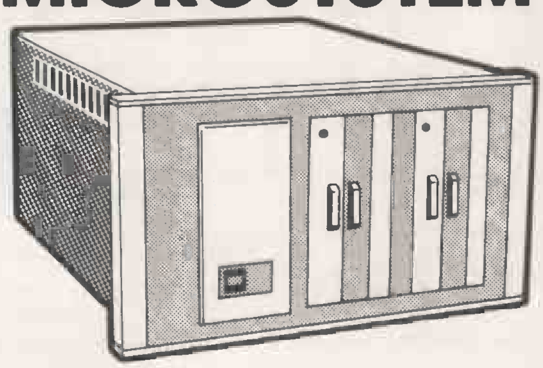

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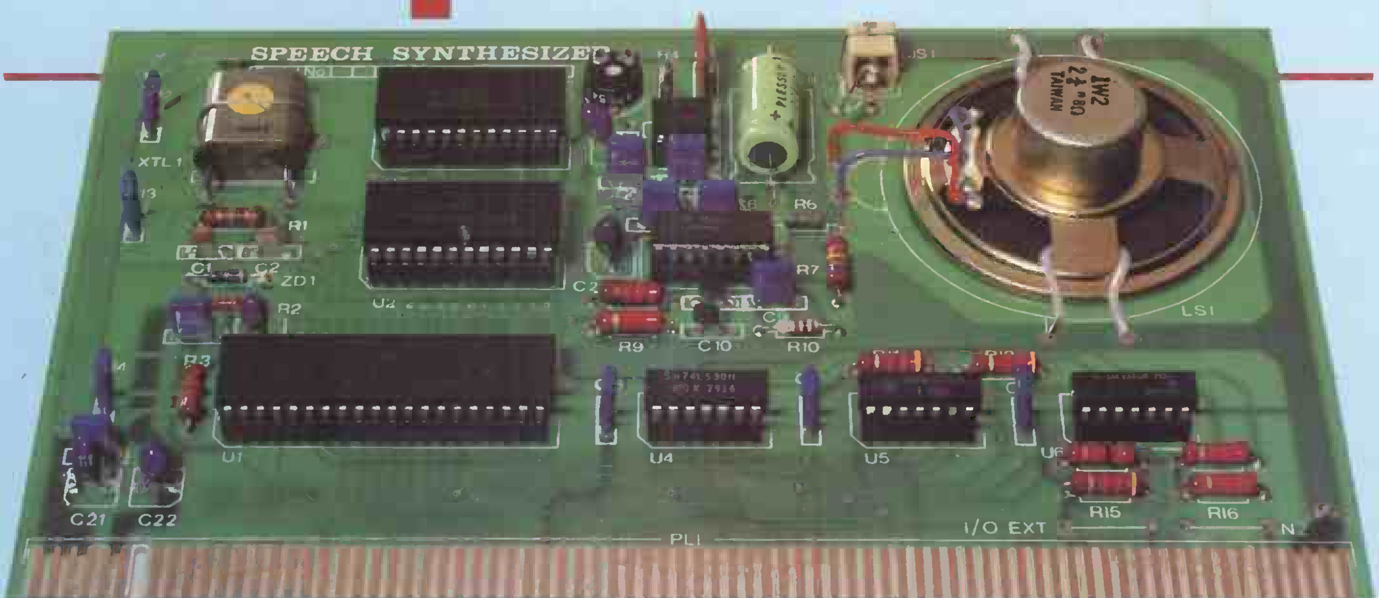

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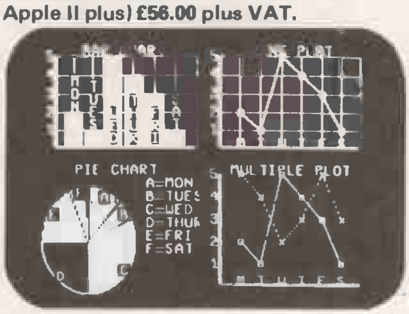

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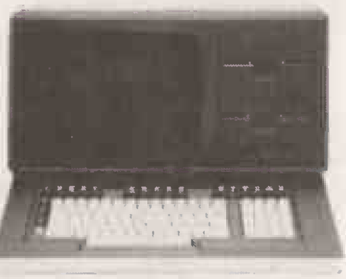

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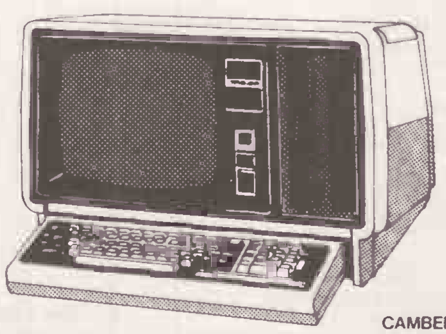

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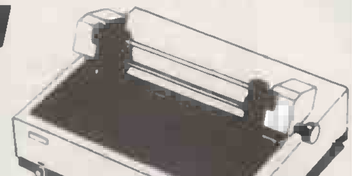

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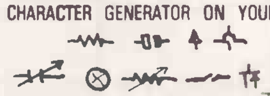

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7422	22p
7423	25p
7425	30p
7426	30p
7427	25p
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7450	80p
7451	17p
7453	17p
7454	17p
7460	17p
7470	17p
7472	36p
7473	30p
7474	32p
7475	30p
7476	38p
7480	32p
7481	50p
7482	100p
7483a	84p
7484	60p
7485	100p
7486	110p
7489	30p
7490A	210p
7491	30p
7492A	60p
7493A	40p
7494	30p
7495A	84p
7496	60p
7497	5p
74100	180p
74107	100p
74109	34p
74116	40p
74118	100p
74119	100p
74120	100p
74121	110p
74122	34p
74123	48p
74125	60p
74126	60p
74128	60p
74132	60p
74136	60p
74141	50p
74142	200p
74145	90p
74147	120p
74148	100p
74150	120p
74151A	50p
74153	50p
74154	90p
74155	60p
74156	60p
74157	50p
74159	120p
74160	70p
74161	70p
74162	70p
74163	70p
74164	90p
74165	90p
74166	90p
74167	200p
74170	200p
74172	300p
74173	90p
74174	75p
74175	75p
74176	70p
74177	90p
74178	100p
74180	80p
74181	160p
74182	90p
74184A	120p
74185	120p
74186	500p
74188	325p
74190	75p
74191	75p
74192	75p
74193	75p
74194	90p
74195	95p
74196	75p
74197	80p
74198	120p
74199	120p
74221	90p
74251	100p
74259	120p
74278	200p
74279	110p
74283	140p
74284	250p
74285	250p
74290	100p
74293	100p
74298	100p
74365	60p
74366	60p
75467	60p
74368	60p
74390	100p
74393	120p
74490	150p

74LS SERIES

74LS00	14p
74LS02	14p
74LS03	18p
74LS04	16p
74LS05	20p
74LS08	20p
74LS09	20p
74LS10	20p
74LS12	30p
74LS11	30p
74LS13	30p
74LS14	50p
74LS20	20p
74LS21	30p
74LS22	27p
74LS26	30p
74LS27	38p
74LS30	20p
74LS32	27p
74LS33	27p
74LS37	30p
74LS38	30p
74LS40	25p
74LS42	60p
74LS47	60p
74LS51	24p
74LS55	30p
74LS73	30p
74LS74	27p
74LS75	36p
74LS76	36p
74LS83	70p
74LS85	80p
74LS86	36p
74LS90	40p
74LS92	70p
74LS93	50p
74LS95	60p
74LS96	110p
74LS107	45p
74LS109	60p
74LS112	40p
74LS113	45p
74LS114	45p
74LS122	70p
74LS123	60p
74LS124	180p
74LS125	50p
74LS126	50p
74LS132	60p
74LS133	30p
74LS136	45p
74LS138	55p
74LS139	55p
74LS145	120p
74LS147	160p
74LS148	140p
74LS151	70p
74LS153	60p
74LS154	200p
74LS155	50p
74LS156	50p
74LS157	50p
74LS158	60p
74LS160	90p
74LS161	75p
74LS162	90p
74LS163	75p
74LS164	70p
74LS165	100p
74LS166	120p
74LS173	110p
74LS174	80p
74LS175	70p
74LS181	200p
74LS190	75p
74LS191	75p
74LS192	75p
74LS193	75p
74LS194	75p
74LS195	75p
74LS196	75p
74LS197	90p
74LS221	90p
74LS240	120p
74LS241	120p
74LS242	90p
74LS243	90p
74LS244	100p
74LS245	120p
74LS247	140p
74LS251	75p
74LS253	75p
74LS257	75p
74LS258	75p
74LS259	100p
74LS266	100p
74LS273	120p
74LS279	55p
74LS283	75p
74LS298	160p
74LS299	300p
74LS323	250p
74LS324	150p
74LS348	200p
74LS365	48p
74LS367	48p
74LS368	48p
74LS373	120p
74LS374	120p
74LS375	120p
74LS377	120p
74LS378	100p
74LS390	90p
74LS393	90p
74LS399	200p
74LS445	140p
74LS640	300p
74LS641	450p
74LS642	450p
74LS643	450p
74LS644	450p
74LS668	100p
74LS670	225p

74S SERIES

74S00	60p
74S04	60p
74S05	75p
75S08	75p
74S10	60p
74S20	60p
74S30	60p
74S32	90p
74S37	90p
74S64	60p
74S74	90p
74S85	300p
74S86	180p
74S112	120p
74S114	120p
74S124	300p
74S132	160p
74S133	75p
74S138	225p
74S139	225p
74S157	250p
74S174	250p
74S175	320p
74S194	350p
74S241	450p
74S260	70p
74S373	400p
74S374	400p

93 SERIES

9301	160p
9302	175p
9308	316p
9310	275p
9311	275p
9312	160p
9314	165p
9316	225p
9321	225p
9322	150p
9334	360p
9368	250p
9370	300p
9374	200p

4000 SERIES

4000	15p
4001	18p
4002	20p
4006	70p
4007	20p
4008	70p
4009	40p
4010	40p
4011	16p
4012	25p
4013	35p
4014	75p
4015	70p
4016	35p
4017	50p
4018	70p
4019	45p
4020	65p
4021	75p
4022	70p
4023	20p
4024	40p
4025	20p
4026	130p
4027	40p
4028	60p
4029	75p
4030	40p
4031	170p
4034	200p
4035	110p
4036	295p
4039	295p
4040	60p
4041	80p
4042	65p
4043	75p
4044	70p
4046	80p
4047	75p
4048	55p
4049	30p
4050	30p
4051	65p
4052	80p
4053	65p
4054	130p
4055	125p
4056	120p
4059	500p
4060	90p
4063	100p
4066	35p
4067	400p
4068	15p
4069	20p
4070	30p
4071	25p
4072	25p
4073	25p
4075	25p
4076	60p
4081	22p
4082	27p
4086	72p
4089	150p
4093	45p
4094	200p
4095	95p
4096	95p
4097	340p
4098	90p
4099	120p
40100	220p
40101	132p
40102	180p
40103	180p
40104	99p
40105	120p
40106	50p
40107	60p
40108	470p
40109	100p
40110	300p
40114	250p
4502	70p
4503	50p
4507	45p
4508	200p
4510	70p
4511	80p
4512	80p
4514	200p
4515	200p
4516	75p
4518	70p
4520	80p
4521	210p
4526	90p
4527	150p
4528	80p
4532	110p
4534	500p
4536	300p
4538	120p
4543	140p
4553	320p
4556	60p
4560	180p
4569	180p
4572	30p
4583	100p
4584	50p
4585	100p
4724	150p
40097	90p
14411	700p
14412	900p
14433	1100p
14599	290p

CPUs

1600	1200p
1802C	750p
2650A	1600p
6502	550p
6502A	700p
6800	375p
6802	650p
6809	1600p
INS8060	1000p
8080A	450p
8085A	650p
9980	2000p
Z80	550p
Z80A	650p

CHARACTER GENERATORS

3257A	1000p
R03-2513 U.C.	650p
R03-2513 L.C.	700p
74S262	1000p

CRT CONTROLLER

MC6845	1000p
MC6847	£11
SFF96364	1100p
TMS9918	6000p

PERIPHERALS

3242	800p
3245	450p
6522	600p
6532	800p
6820	375p
6821	180p
6850	180p
6852	370p
8155	800p
8205	320p
8212	175p
8216	200p
8224	250p
8226	250p
8228	250p
8251	400p
8253	800p
8255	400p
8257	800p
8259	800p
8279	950p
Z80-CTC	550p
Z80A-CTC	600p
Z80-P10	550p
Z80DART	£12
Z80ADART	£15
Z80ADMA	£12
Z80A-P10	600p
Z80-510-1	2400p

KEYBOARD ENCODER

AY-5-2376 700p

UARTS

AY-5-1013A	350p
AY-3-1015D	400p
IM6402	450p

FLOPPY DISC CONTROLLER

FD1791	£30
FD1771	£25

MINI DRIVE

FD-50A £140

MEMORIES

RAMS

2101-4L	400p
2102-2L	120p
2111-4L	300p
2112A	300p
2114-2L	300p
2114-3L	250p
2114-4L	200p
4027-3	350p
4044-4	600p
4116-2	200p
4118-4	600p
5101	300p
6810	200p
6116	1200p
6514	500p
4164	1600p

ROMS

74S188	275p
74S189	275p
74S201	350p
74S287	350p
74S387	350p
74S470	650p
74S471	650p
74S472	900p
74S571	900p
74S573	900p

(Many more stocked)

EPROMS

1702A	700p
2708	300p
2716(+5v)	400p
2732	£9
2532	£9

INTERFACE ICs

AD561J	1400p
AD7524	600p
DAC1408-8	200p
DM8131	375p
DP8304	450p
DS8835	250p
DS8836	150p
DS8838	225p
MC1488	75p
MC1489	75p
MC3446	325p
MC3480	800p
MC3487	300p
MM58174	1200p
75107	160p
75110	160p
75154	175p
75182	230p
75324	375p
75361	150p
75363	400p
75365	150p
75451/2	72p
75491/2	70p
8T26	160p
8T28	160p
8T95	160p
8T97	160p
81LS95	120p
81LS96	140p
81LS97	120p
81LS98	140p
9601	110p
9602	220p
TMS9914	£25

FERRANTI

ZN425E-8	400p
ZN427E-8	750p

MISCELLANEOUS

6MHz UHF Mod.	350p
8MHz UHF Mod.	450p
16 Key Pad	450p
S100 Busboard	1500p
DIN41612 Plug	450p
DIN41612 Socket	450p
43 way Edge Con	250p
31 way Plug 0.1"	120p
31 way SKI 0.1"	120p
Logic Probe LP1	£31
Logic Probe LP2	£18
Logic Probe LP3	£49
Zero Insertion Force Socket 24 pin	£7

DIL Switches

4 way SPST	90p
6 way SPST	105p
8 way SPST	120p

CRYSTALS

32.768KHz	250p
100KHz	300p
200KHz	370p
1.0MHz	320p
1.008MHz	350p
1.8432MHz	325p
2.00MHz	325p
2.45760MHz	325p
3.276MHz	300p
3.579MHz	175p
4.00MHz	290p
4.194MHz	300p
4.43MHz	125p
5.0MHz	325p
6.0MHz	300p
6.144MHz	300p
7.0MHz	300p
7.168MHz	300p
8.00MHz	300p
8.867MHz	300p
10.00MHz	310p
10.7MHz	300p
12.0MHz	350p
16.00MHz	350p
18.00MHz	300p
18.432	350p
19.968MHz	390p
26.690MHz	350p
27.145MHz	325p
38.6667MHz	350p
48.0MHz	300p
55.5MHz	400p
116.0MHz	350p

LOW PROFILE DIL SOCKETS BY TEXAS

8 pin	9p	18 pin	16p	24 pin	22p
14 pin	10p	20 pin	18p	28 pin	26p
16 pin	11p	22 pin	20p	40 pin	30p

WIRE WRAP SOCKETS BY TEXAS

8 pin	30p	18 pin	50p	24 pin	70p
14 pin	35p	20 pin	60p	28 pin	80p
16 pin	40p	22 pin	65p	40 pin	100p

VOLTAGE REGULATORS

Fixed Plastic T0-220

1A	+ve		−ve	
5v	7805	55p	7905	60p
6v	7806	55p	7906	80p
8v	7808	55p	7908	80p
12v	7812	55p	7912	60p
15v	7815	55p	7915	60p
18v	7818	55p	7918	80p
24v	7824	55p	7924	80p

100mA +ve	TO-92			
5v	78L05	30p	79L05	70p
12v	78L12	30p	79L12	70p
15v	78L15	30p	75L15	70p

OTHER REGULATORS

LM309K	140p		
LM317T	200p	78MGT2C	140p
LM323K	500p	79GUIC	225p
LM723	37p	79HGKC	650p
78GUIC	200p	78P05	750p
78H05	550p	RC4195NB	150p
78HGKC	600p	TL497	300p

MINI FLOPPY DISC DRIVE

TEAC FD-50A 40 TRACKS
S/D DENSITY
£140 + £2 P&P

SPEECH SYNTHESISER

(A Project by TEXAS INSTRUMENTS LTD)

- Superb major solid state speech project for under £100.
- Promises to have a dramatic impact on State-of-Art Electronics — now and for generations to come.
- A talking library of over 200 words with further expansion space.
- Easy interfacing to a microcomputer through a few lines of BASIC.
- Pitch control has exciting electronic music applications.

A re-print of original constructional article by E & MM (June 81) available at 65p plus large S.A.E.

COMPLETE KIT OF PARTS (INC. PCB) £87

(NB: We are fully authorised TEXAS INSTRUMENTS distributor for above project)

ACORN ATOM

Kit £120 Built £150

SOFTY

Kit £99 Built £120
Ideal Software dev. tool

SPECIAL OFFERS

	1-24	25-99	100
2114L (450ns)	1.30	1.20	1.10
2716 (+5v)	3.00	2.75	2.50
4116 (200ns)	1.20	1.10	1.00

We carry large stocks of Memories, TTLs, CMOS; LINEARS, TRANSISTORS AND OTHER SEMI-CONDUCTORS and welcome inquiries for volume quantities.

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P&P: Please add 40p
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Govt., Colleges, etc. orders accepted.
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Telex: 922800

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NASBUS COMPATIBLE NEWS

More great deals from 6 Nascom Dealers

A NASCOM-2 BASED SYSTEM FOR £1549 + VAT

The proven Nascom-2 microcomputer can now be bought as a complete system from £1549 + VAT. For this price you get the Nascom-2 kit, 16K RAM board kit, Kenilworth case with 2 card frame, Centronics 737 printer, 10 inch monitor, and the Gemini Dual Drive Floppy Disk System. The CPU and RAM boards are also available built – the additional cost is available on application.

GEMINI G805 FLOPPY DISK SYSTEM FOR NASCOM-1 & 2

It's here at last. A floppy disk system and CP/M.

CP/M SYSTEM. The disk unit comes fully assembled complete with one or two 5¼" drives (FD250 double sided, single density) giving 160K per drive, controller card, power supply, interconnects from Nascom-1 or 2 to the FDC card and a second interconnect from the FDC card to two drives, CP/M 1.4 on diskette plus manual, a BIOS EPROM and new N2MD PROM. All in a stylish enclosure.

Nascom-2 Single drive system. **£450 + VAT**
Nascom-2 Double drive system **£640 + VAT**
Nascom-1 Single drive system. **£460 + VAT**
Nascom-1 Double drive system **£650 + VAT**
Additional FD250 drives .... **£205 + VAT**

D-DOS SYSTEM. The disk unit is also available without CP/M to enable existing Nas-Sys software to be used. Simple read, write routines are supplied in EPROM. The unit plugs straight into the Nascom PIO.

Single drive system .... **£395 + VAT**
(please state which Nascom the unit is for)
Certain parts of the CP/M and D-DOS disk systems are available in kit form.
Details available on request.

KENILWORTH CASE FOR NASCOM-2

The Kenilworth case is a professional case designed specifically for the Nascom-2 and up to four additional 8" x 8" cards. It has hardwood side panels and a plastic coated steel base and cover. A fully cut back panel will accept a fan, UHF and video connectors and up to 8 D-type connectors. The basic case accepts the N2 board, PSU and keyboard. Optional support kits are available for 2 and 5 card expansion.

Kenilworth case .... **£49.50 + VAT**
2-card support kit .... **£7.50 + VAT**
5-card support kit .... **£19.50 + VAT**

GEMINI EPROM BOARD

This Nasbus compatible EPROM board accepts up to 16, 2716 or 2708 EPROMs. It has a separate socket for the MK36271 8K BASIC ROM for the benefit of Nascom-1 users. And for Nascom-2 users, a wait state for slower EPROMs. The board also supports the Nascom Page Mode Scheme.

EPROM Board (kit)...................... **£55 + VAT**
EPROM Board (built & tested)..... **£70 + VAT**

CASSETTE ENHANCING UNIT

The Castle interface is a built and tested add-on unit which lifts the Nascom-2 into the class of the fully professional computer. It mutes spurious output from cassette recorder switching, adds motor control facilities, automatically switches output between cassette and printer, simplifies 2400 baud cassette operating and provides true RS232 handshake.

Castle Interface Unit .... **£17.50 + VAT**

A-D CONVERTER

For really interesting and useful interactions with the 'outside world' the Milham analogue to digital converter is a must. This 8-bit converter is multiplexed between four channels – all software selectable. Sampling rate is 4KHz. Sensitivity is adjustable. Typical applications include temperature measurement, voice analysis, joystick tracking and voltage measurement. It is supplied built and tested with extensive software and easy connection to the Nascom PIO. Milham A-D Converter (built and tested).... **£49.50 + VAT**

PROGRAMMER'S AID

For Nascom ROM BASIC running under Nas-Sys. Supplied in 2 x 2708 EPROMs. Features include: auto line numbering; intelligent renumbering; program appending; line deletion; hexadecimal conversion; recompression of reserved words; auto repeat; and printer handshake routines. When ordering please state whether this is to be used with Nas-Sys 1 or 3. **Price £28 + VAT.**

DUAL MONITOR BOARD

A piggy-back board that allows N1 users to switch rapidly between two separate operating systems. **Price (kit) £6.50 + VAT.**

NASCOM-2 Microcomputer Kit **£225 + VAT**
NASCOM-1 Microcomputer Kit **£125 + VAT**
Built & tested **£140 + VAT**
IMP Printer. Built & tested .... **£325 + VAT**

CENTRONICS 737 MICRO PRINTER

A high performance, low price, dot-matrix printer that runs at 80cps (proportional) and 50cps (monospaced). This new printer gives text processing quality print. And can print subscripts and superscripts. It has 3-way paper handling and parallel interface as standard. Serial interface is optional. **Price £425 + VAT.** Fanfold paper (2000 sheets) **£18 + VAT.**

GEMINI 'SUPERMUM'

12 x 8 piggy-back board for Nascom-1 offering five-slot motherboard, quality 5A power supply and reliable buffering with reset jump facility. **Kit Price £85 + VAT.**

BITS & PC's PCG

5 x 4 board which plugs straight into Nascom-2. Operates on cell structure of 128 dots, producing 64 different cells. Once defined, each cell may be placed anywhere, any number of times on screen simultaneously. Max screen capacity: 768 cells. Dot resolution: 384 x 256 = 98304. Many other features including intermixing of alpha-numeric characters and pixels. **Price (kit) £60 + VAT.**

GEMINI 64K RAM BOARD

Newly developed Nasbus compatible board that can accommodate up to 64K of RAM including Page Mode facility. **Kit Prices: £110 (16K), £130 (32K), £150 (48K), £170 (64K). Add VAT to all prices.**

All prices are correct at time of going to press and are effective 1st June 1981.

DISKPEN

The powerful text editor written for the Nascom is now available on a 5¼ inch floppy disk with a number of new features. **Price £43.25 + VAT.**

PORT PROBE

Allows monitoring of input and output of Nascom PIO. This board can generate interrupts and simulate handshake control. **Price (kit) £17.50 + VAT.**

HEX & CONTROL KEYPADS

Hexadecimal scratchpad keyboard kit for N1/2: **Price £34 + VAT.**
As above but including (on the same board) a control keypad kit to add N2 control keys to N1. **Price £40.50 + VAT.**

BASIC PROGRAMMER'S AID

Supplied on tape for N1/2 running Nas-Sys and Nascom ROM BASIC. Features include auto line number, full cross-reference listing, delete lines, find, compacting command, plus a comprehensive line re-numbering facility. **Price £13 + VAT.**

GEMINI EPROM-PROG.

2708 (multi-rail) and 2716 (single-rail) EPROM programmer kit controlled by N1/2 PIO. Supplied with comprehensive software for use with Nas-Sys. **Kit Price £29.50 + VAT.**

WE STOCK Nasbus COMPATIBLE COMPUTER PRODUCTS

All the products are available while stocks last from the Nascom dealers below.
(Mail order enquirers should telephone for delivery dates and post and packing costs.) Access & Barclaycard welcome.

BITS & PC'S
4 Westgate, Wetherby, W. Yorks.
Tel: (0937) 63774.

BUSINESS & LEISURE MICROCOMPUTERS
16 The Square, Kenilworth, Warks.
Tel: (0926) 512127.

ELECTROVALUE LTD.
680 Burnage Lane, Burnage, Manchester M19 1NA.
Tel: (061) 432 4945.
28 St Judes, Englefield Green, Egham, Surrey TW20 0HB.
Tel: (0784) 33603. Tlx: 264475.

TARGET ELECTRONICS
16 Cherry Lane, Bristol BS1 3NG.
Tel: (0272) 421196.

INTERFACE COMPONENTS LTD.
Oakfield Corner, Sycamore Road, Amersham, Bucks.
Tel: (02403) 22307. Tlx: 837788.

HENRY'S RADIO
404 Edgware Road, London W2.
Tel: (01) 402 6822.
Tlx: 262284 (quote ref: 1400).

• Circle No. 358

OHIO SCIENTIFIC COMPUTERS

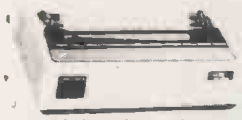
CHEAPO EXPANSION OFFER
Buy a 610 expansion board with 8K ram on board and space for another 16K for £159 and get a free 5V 3A power kit and any extra ram you want for £3/K. Buy a mini-floppy + case + power supply + 2 copies of DOS for £275 and we will do the extra ram for £2/K (Max 16K). We can also supply a version to suit UK101.

SUPERBOARD 3
Superboard 3 £159. Power supply kit £11.95. Modulator £3.50. Guard band kit £10. 4K extra ram £15.60. Case £27. Cassette recorder £18. Cegmon improved monitor rom £29.50. Assembler/Editor tape £25. Word processor program £10. Display expansion kit 30 lines × 54 characters for Superboard 2 (not 3) £14. Wemon £19.95. Centronics interface kit £10.

SPECIAL OFFER
Superboard 3 + power supply and modulator kit + guard band kit (converts the display to 32 × 32, gives 1200 and 300 Baud tape speeds, increases computing speed by 50% and converts to 50 Hz). Only £172.

SERIES 2 CHALLENGER
Microcase versions 4K £212. 8K £228.

PRINTERS



Buy any of the below and get a free interface kit and word processor program for UK101 or Superboard:— OKI Micrline 80 (illustrated) £299. Epson MX80 tractor £359. Epson MX80 tractor + friction £399. Epson MX70 £279. Epson TX80 £295.
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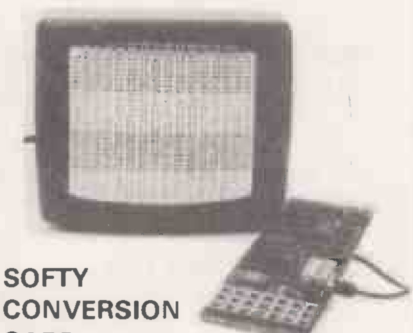

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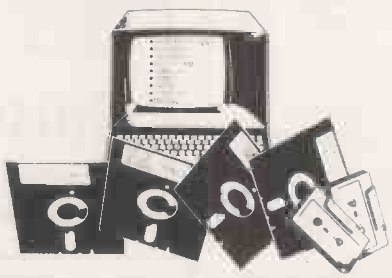

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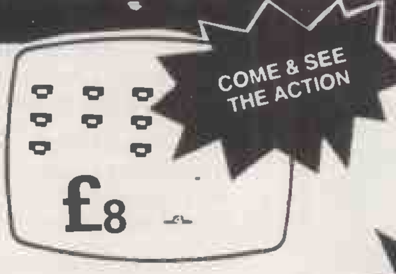

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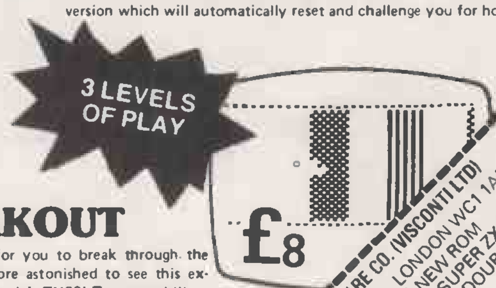

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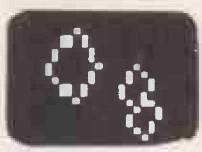

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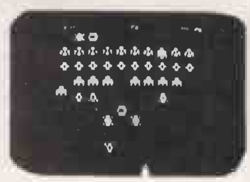

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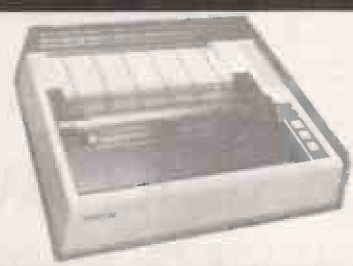

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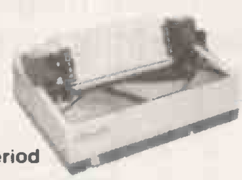

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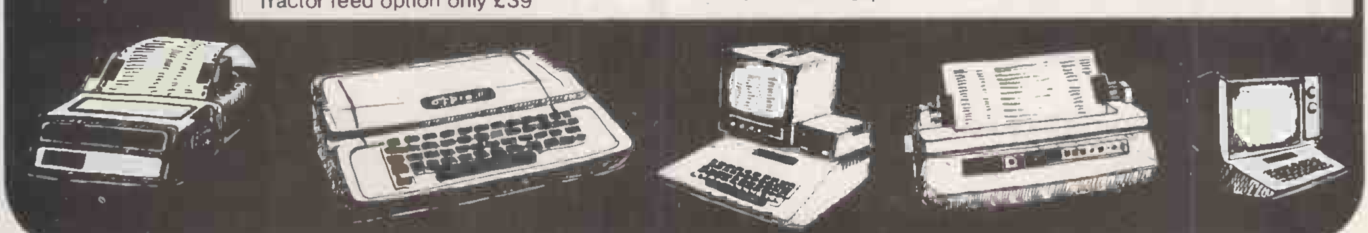

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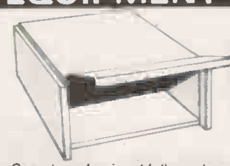

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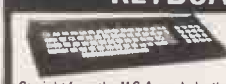

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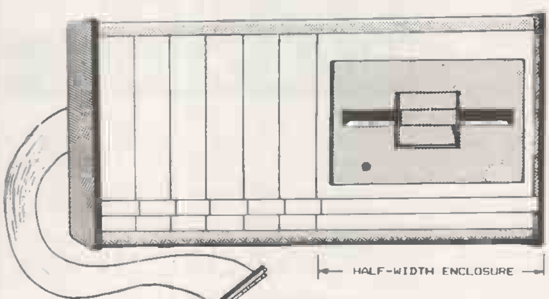

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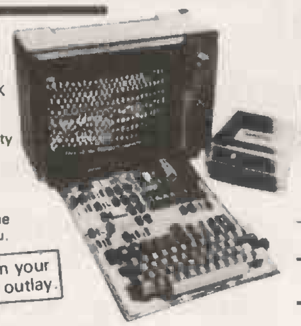

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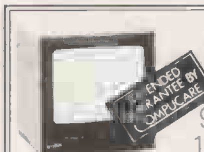

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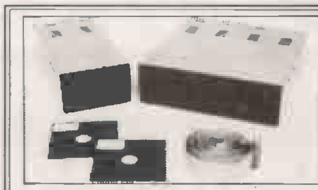

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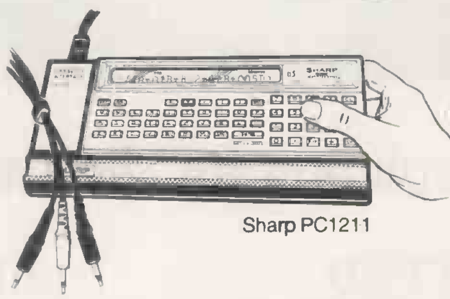

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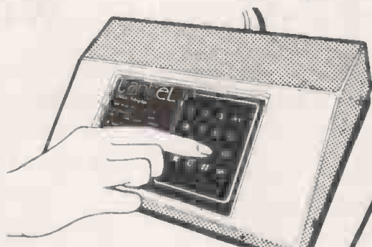

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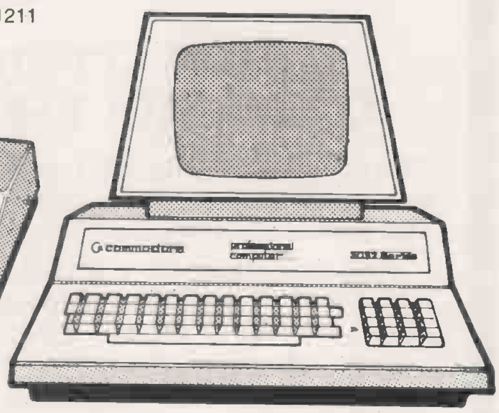

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